UNIVERSITY OF ALBERTA

# CANADIAN DEMAND FOR CHICKEN DISAGGREGATED BY CUT AND PRODUCT

BY

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A THESIS SUBMITED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE
IN

AGRICULTURAL AND RESOURCE ECONOMICS

DEPARTMENT OF RURAL ECONOMY

EDMONTON, ALBERTA

Spring 2005

0-494-08155-4

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## ABSTRACT

This thesis examines Canadian demand for chicken products and parts by using national level retail scanner data. By using weekly data the intricate relationships between the products are discovered which may have been lost with a more aggregated study. A two stage AIDS model is estimated using TSP version 4.5 and log-likelihood and weak reparability tests are preformed to validate the model structure and correctly identify other variables effecting chicken demand. The processors can use the results of this estimation to develop a more optimal marketing strategy for their products. Simulation experiments are conducted to show the effect of different marketing strategies by the pork and chicken industry. The results of this thesis will be able to assist with policy development for the federal and provincial marketing boards to insure that the welfare of producers is maintained in a continuously evolving market.

## ACKNOWLEDGEMENTS

First and foremost I would like to thank my supervisors Dr. Ellen Goddard and Dr. Sean Cash for their inspiration and guidance over the course of the thesis. Special thanks also go to Dr. J.R. Unterschultz for first noticing my potential as a graduate student and bringing me into the department.

Thank you to all the various fund providers for my thesis including the Cooperative Program in Agricultural Marketing and Business, the Poultry Industry Council, Alberta Chicken and Turkey Producers, and the Alberta Livestock Industry Development Fund.

I am especially grateful to Cindy Wang for her assistance and patience in making sure that I understood the work I was doing. Last but not least I would like to acknowledge my family for their unwavering support throughout all of my studies.

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## Chapter 1 Background and Proposal

### 1.1 Canadian Chicken Industry Background

The Canadian poultry industry is an important sector in the agricultural economy. In 2002 the farm value of poultry products was about $1.4 billion, which contributes 4.2% to total farm cash receipts. A total of 2800 chicken farmers operate in Canada producing a total of 926,840 tonnes of chicken and over 60% of them are located in the eastern Canada. The poultry industry today faces many challenges, for instance, increasing concerns about food safety in the production and processing stages. Avian influenza, E. coli, salmonella, and Campylobacter are just a few of the most commonly sited concerns. Supply management also creates potential challenges for the industry since the current World Trade Organization talks are focusing on the reduction of agricultural supports and barriers to trade. The real concern is about the legality of exports, if exports were shut off as they have been in dairy what might happen to the industry? The pricing of chicken in Canada by the producer run supply management marketing boards is potentially a concern. It is possible that the pricing system used today may not be the best possible and improving the quality of information in the pricing system could result in a better redistribution of welfare.

In Canada, the per capita consumption of chicken has been increasing over the last thirty years from 15 kg in 1976 to 30.6 kg in 2002. The expenditure share devoted to chicken has also been increasing within the overall meat budget of the consumer; in the late 1960's a person would have used approximately 10% of their meat budget for chicken but by 2001 they used 33%. Chicken's increasing popularity with consumers could be caused by many factors but some of the main ones may be its price in

comparison to beef and pork at the retail store. Also, consumer's preferences are changing concerning the risks associated with diets high in fat. For more than 20 years the trend has been towards easy to prepare foods since many families have two members working, time and family income affects the decision on what types of food products are bought. Chicken has found its way into food products designed around cooking convenience and by doing so chicken has become more appealing to the consumer. People are also eating more food prepared outside the home and this has also increased for the same reason as consumption of prepared foods. The fast food industry is another major force driving increased chicken consumption; the introduction of mechanically separated chicken revolutionized the industry by allowing people to choose poultry products more often when they go out to eat (e.g. Chicken McNuggets). The fast food industry is also a large advertiser, for example in 2001 the restaurant industry in total spent approximately $6 million per quarter just on chicken products.

There are six main levels which make up the market structure of the Canadian chicken industry. The first stage is the breeders who supply the genetics and the breeding stock to the hatcheries. Along with the hatcheries the feed companies provide the nutritional inputs that are necessary for the farmers to raise the birds. After the birds reach a targeted age or target weight, they are sold to the primary processors whose job is to slaughter the chickens and provide the cuts that the retail and secondary processors require. Not all of the slaughtered birds go on to secondary processing, but if they do it is the processors job to add value to the product by seasoning, breading, resizing, or even cooking the meat before it goes onto the store shelf. There are 135 primary processors in Canada and the top five are Flamingo Foods, Dorchester Group, Lilydale Co-op, Maple

Leaf Poultry and Maple Lodge Farms. It is important to note that there are also 337 secondary processors, 69 of which also have primary slaughtering capacity, however some organizations like Campbells Soup Co. only do further processing. After the poultry meat is processed it is sold to the retail or food service industry or export brokers, the domestic or international consumer is the final step in the supply chain.

The poultry industry in Canada is regulated at the national level by the Chicken Farmers of Canada (CFC) who were established under the Farm Product Agencies Act and who are mandated by the Canadian government to administer the supply management system. The board of the CFC is made up of 14 members who elect a chair from one of the 10 producer members representing the provincial marketing boards. Besides the ten producer representatives two processor representatives are chosen by the Canadian Poultry and Egg Processors Council. Two additional members, one representing the further processors and the other representing the restaurant industry round out the board. Since 1995 they have been using a bottom up approach to manage the system. The way it works is that the processors in all of the provinces tell their provincial marketing boards what their demand for chicken will be and the provincial boards report back to the CFC. The CFC then allocates quota to the provincial boards based on their requests and relative to their historic level of production. Since chicken demand has been growing the National Allocation Agreement allows for production increases provided that the national cap of 5% of the adjusted base is not surpassed. Any individual province can grow at 8% over the adjusted base within a region, however each region still has a 5% cap with any one region having a 1.5% flexibility in any one period. Many scenarios can induce an automatic review of the cap, but this is the general

framework of how the allocation system works. Production quota is allocated to individual producers at the provincial level by provincial marketing boards.

Supply management provides for poultry imports, and the level is allowed to grow over time. For example, Canadian firms are allowed to source 7.5% of domestic production from the US or other suppliers. Imports are managed through a TRQ (tariff rate quota), where imports are allowed relatively tariff free until a certain pre-specified quantity is reached, but then a highly restrictive tariff is placed on any additional imported product.

**Table 1.1** Quantity of Chicken Imported Into Canada based on Issuance of Import Permits Under the TRQ ('000kg eviscerated weight).

| **Product** | **1997** | **1998** | **1999** | **2000** | **2001** |
|---|---|---|---|---|---|
| Live Chicken | 109 | 0 | 0 | 552 | 143 |
| Whole | 1065 | 539 | 354 | 104 | 115 |
| Parts | 46,510 | 49,966 | 55,184 | 56,145 | 57,013 |
| Further Processed | 5969 | 5102 | 3978 | 6548 | 7909 |
| **Total** | **53,653** | **55,607** | **59,516** | **63,349** | **65,179** |

Source: CFC: Chicken Data Handbook 2002.

Imports have to be viewed in a particular way, the total quantity has been increasing but it is more meaningful to look at the type of chicken products individually to examine the more intricate relationships. Live chicken imports are sporadic and seem to depend on production relationships at the farm level rather then the processing or retail activity. Whole chicken imports have gone down since 1997, but the import of parts and further processed chicken has increased substantially. Most of the Canadian imports are white meat such as high demand parts like wings, the food service industry is also a major importer of chicken pieces, generally importing individual cuts to meet their needs.

In October 1996 the CFC approved a national chicken export policy which took effect on March 16, 1997. According to the CFC this was done to allow Canadian processors to compete in an expanding world chicken market. Generally the rules of the export policy state that export quota must not make up more than 8% of a province's domestic allocation, and that processors must commit that the amount of additional production granted for export will in fact be exported or any additional volume left on the domestic market will be fined $0.44 per kg. Since 1989 the total volume of exports has increased considerably from ~1000 metric tonnes in 1990 to ~79,000 in 2001 (CFC Chicken Data Handbook 2002). Traditionally the top five export markets are Russia, China, Cuba, South Africa, and the USA. However exports to Cuba have decreased significantly since the US opened trade in poultry products with that country (USDA GAIN Report 2003). The export policy is designed so that it causes little disturbance in the domestic market and is "consistent with Canada's international trading rights and obligations." The CFC believes this is a good policy for everyone including processors and producers by making a "more dynamic domestic industry". Under the national policy a framework was created allowing additional chicken to be produced solely for export. For example, in Ontario processors who desire chicken for export submit a request to the provincial marketing agency, who upon receiving approval from the CFC allows the production to take place. The price and the volume are directly determined between the individual processor and producers.

However, not everyone sees this policy as just a means for the industry to compete in the world market. The growing demand for chicken has given Canada an opportunity to market lower demand dark meat like chicken legs and backs to the world

while retaining higher demand breast meat and wings. White meat demand is so much higher that processors and retailers are able to charge a premium for it. Dark meat is not in favor due to the higher fat content in the meat so consumers tend to prefer white meat as a low fat alternative even compared to beef and pork. Dark meat is also a non-homogeneous product compared to white meat with the presence of tendons and other objects in the meat. With the exception of chicken wings the retailers have a harder time moving the dark meat out of the store, implying there still could be a surplus even with the current export policy.

The export policy does not specify that all of the parts of a chicken produced under market development get exported. In fact in the CFC's market development policy, it explicitly states that intra-provincial and inter-provincial trade can only be in dark meat to another organization issued a Market Development Policy Volume Conformation letter by the Department of Foreign Affairs and International Trade, a measure probably designed to retain an adequate supply of white meat in the provincial markets. The export policy allows processors, according to a recent FAS (2002) report, to secure access to a larger quantity of white meat for the domestic market by exporting the dark meat offshore. This policy may cause problems in future WTO negotiations since other countries could claim this meat is being dumped on the world market. Supply management remains at the heart of the controversy, since some could argue that due to supply management's tight control over domestic production and importation, the higher domestic price allows the processors to use export contracts to raise the birds for their white meat only, and discard the dark meat on the world market. A strategy of this sort may not be possible if supply management did not exist. Producers also may be able to

produce export birds at prices lower then would be possible in the absence of supply management since supply management ensures a reasonable (most likely profitable ) price for the domestic birds.

**1.2 Economic Problem**

The Canadian poultry market is supply managed with domestic production controlled through production quotas and imports controlled through tariff rate quotas. The marketing board determines production quota, export permits and negotiates price with processors. There is increasing concentration in processing and retailing in Canada. The chicken market has evolved considerably since 1978 when the national system was established. There has been a proliferation of forms and places in which chicken is sold since 1978. As well the export policy has encouraged significant production for export (largely dark meat products exported, white meat products kept for the domestic market). The current price negotiations determine base live chicken prices to be paid by processors considering factors such as price of producer inputs, trends in the wholesale prices received by processors, trends in the price of substitutes for chicken etc. Processors participate in the negotiation with their position affected by what they think further processors and retailers will pay for the eviscerated chicken. Further information on the consumer's preferences for chicken products by cut, and by type of further processing could provide critical information to improve the quality of negotiation positions for producers and processors. The difference in price between poultry products in the supermarket is evident, generally the higher the degree of processing the higher the price. White meat parts sell for a higher price as compared to dark meat parts, also chicken sold

by the food service industry is priced much higher even compared to the white chicken meat sold in the retail store.

**Table 1.2** The Price of Chicken for Consumers at Canadian Retail Outlets.

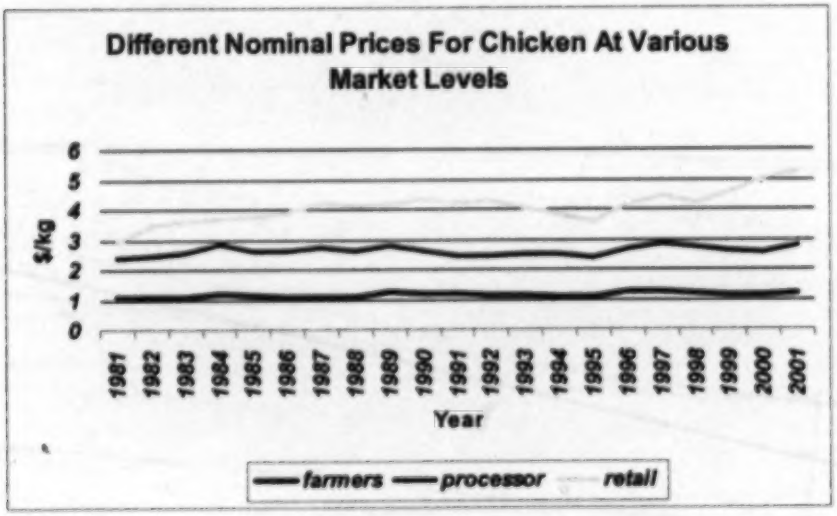
| Cut or Product | Price $/100g | Meat Color | Brand |
|---|---|---|---|
| Frozen Whole | 0.30 | White & Dark | Lilydale |
| Drumsticks | 0.32 | Dark | Market Fresh |
| Wings | 0.66 | White | No Name |
| Breast | 1.35 | White | Maple Lodge |
| Kiev | 1.95 | White | PC |
| Nuggets | 2.07 | White | KFC |
| Burger | 2.24 | White | McDonalds |

Source: Chris Panter March 2003.

Products like "Chicken Kiev" are "specially defined mixtures" and thus are exempt from the TRQ under the "import to compete" program, which is another opportunity for increased chicken imports. With the rapid rate of new product development, many of the new products fall into this category and this is causing the CFC some concern in its ability to keep the domestic market protected. In order to keep supply management viable it keeps calling on the government to expand the number and types of products covered under the TRQ. According to the GAIN Report (CA3052) this could be a reason why the CFC with its strict structure is less able to respond to new product creation and demand. The main economic problem is supply management and how the industry responds to the needs of the processors, there is no good information on pricing and there is a need for a better understanding on how chicken can be better marketed. Many groups would be interested in knowing how to market chicken better. The producers have a vested interest in seeing the price they receive for chicken is as high as possible, and through proper allocation in the market the producer surplus can be

maximized. The following graph shows the price that various groups get for chicken in Canada and how that relationship is changing over time.

Figure 1.1




Source: CFC Chicken Data Handbook 2002.

There has been virtually no change in the price that the producer receives for the chicken. The price that the processors receive is a little more than a dollar higher and has been fairly well correlated with the farm price, but there appears to be some upward movement away from the farm price in the late 1990's. The striking trend is at the retail sector where the price charged for chicken has generally been increasing for twenty years, but after 1995 the rate of increase has been stronger than before. Speculation that the retail sector has significant market power, and that supply management may not be the only cause for higher chicken prices in Canada as compared to the US has resulted because of these trends.

**Table 1.3** Average 2001 Price Levels In Supply Chain In The U.S Compared to Canada

| Farm Price | Processor Price | Retail Price | Location |
|---|---|---|---|
| 1.29 | 1.96 | 3.65 | USA ($/kg Can) |
| 1.18 | 2.82 | 5.28 | Alberta ($/kg Can) |

Source: CFC Chicken Data Handbook 2002
Source: UDSA Livestock Market Report 2001

This comparison illustrates that the average price that farmers receive in Canada can be much lower then in the US (based on the Alberta price at a particular point in time). However, in Canada the retail and processing sector can get a higher price then in the US. The information contained in the previous two figures could be the implication of the difference in the competitiveness between the two markets. Even though this thesis does not look at social welfare measures many groups can benefit from the thesis. The benefit of this thesis is that the board will be able to see the demand profile for different chicken cuts, enabling them to improve the price negotiation process.

Consumers can benefit from an improved negotiation process in that the incentives would be there for the processing and retail firms to provide the type of products being demanded with an adequate quantity. Policy makers in the government and the members of the CFC would be interested in this research in helping to make adjustments to the supply management system which could benefit the producers. Food retailers could benefit by being able to predict sales and future trends in chicken product demand. Stores could have more effective allocation of space for certain types of products and by getting the most value from the chicken products they sell by having appropriate pricing. Society in general will be better off if the availability of chicken products and price determination are improved.

### 1.3 Thesis Objectives

The general objective of this thesis is to gain a better understanding of the demand for chicken in Canada. No studies currently in agricultural economics look at chicken demand for individual products with this level of detail. During the course of the study a model of chicken demand and consumer preference will be built to address the following objectives:

1. Examine aggregate chicken consumption and through the use of scanner data, determine how much is going through grocery stores by cut and brand.
2. Measure the consumer price responsiveness for the various chicken products by estimating own and cross price elasticities of demand by product. The measures of price responsiveness can be used to describe preferences and substitution possibilities for individual chicken products.
3. Develop a model which will help the chicken industry be more informed, so that it can project the impact of other meat marketing strategies (beef, pork) as well as changing price strategies within the chicken product mix to see how that can effect overall sales.

### 1.4 Thesis Outline

In order to achieve the objectives of the thesis an extensive literature review will be conducted in which previous poultry demand studies will be examined. In the literature review previous studies will be examined as well as issues dealing with modeling demand on the basis of the individual product. An exhaustive review of scanner data materials needs to be done as well, followed by an examination of different demand systems to see which one will work the best in this application. A major component of

the data is purchased scanner data from A.C. Neilson. The data time series in nature that consists of scanner data transactions from Canadian supermarkets over a certain period of time.

The institutional setting of the market, how pricing decisions are currently made, and the market structure will also be explained in detail. The issue of seperability will be examined because it is a necessary assumption in order for chicken to be considered distinct from other products especially other meats.

The methods will be discussed in the third chapter. The data sources will be discussed in chapter four, why it is needed, and any adjustments done. Chapter five is the analysis section where the results will be generated and discussed. In the analysis different pricing scenarios can be tested in order to find the implications of different marketing strategies. Chapter six will contain a summary and conclusion of the study.

## Chapter 2 Literature Review

### 2.1 Introduction

This chapter will give the more detailed background necessary before the empirical model can be specified. The literature review is designed to allow the thesis objectives to be satisfied. The first objective centers on examining Canadian chicken consumption using scanner data, in order to determine preferences by cut. The data contains branded and generic products for both fresh and frozen further processed items sold in Canadian retail stores. The previous objective is to measure the price responsiveness associated with various chicken products that processors require by estimating a chicken product demand system, but starting with a review of consumer theory and a discussion about consumer preferences. For an examination of the relationship between "at home vs. away from home" purchases is required, including an overview of household production theory and an examination of the recent trends in the food away from home (FAFH) market. The fourth objective is designed to assist the chicken industry better project future demand along with the impact of other marketing strategies; to satisfy this will require a review of previous chicken demand studies and an explanation of how and why a more disaggregated study using scanner data is superior for managerial applications. A presentation of the Canadian market structure will help in establishing how the objectives of the thesis can be used by industry. The literature review introduction and outline presents a logical flow to the background which needs to be covered in order to narrow the focus of the objectives.

## 2.2 Basic Consumer Theory

Consumers are assumed to be utility maximizers, and utility is the amount of satisfaction that can be derived from the consumption of goods and services. In consumer theory utility is ordinal so that the utility that one individual receives from consuming a good is not directly comparable to another individual's utility derived from consuming the same good. Individuals conduct utility maximization but this process is constrained by the person's budget. Consumers allocate scarce funds across an almost unlimited array of goods and services which have different prices and an optimal utility maximizing choice will be made that does not exceed the budget constraint. The individual spends all of their income and the budget constraint may not allow a consumer to realize every possible choice or desire. For simplicity an assumption of linear budget constraints will be a maintained assumption and that total expenditure ($x= \Sigma_k p_k q_k$) allows the consumer to obtain as many goods as possible (Deaton and Muellbauer, 1980).

### 2.2.1 Axioms of Consumer Theory

In order to establish utility functions consumer's preferences must be clearly defined. According to Deaton and Muellbauer (1980) there are six axioms of choice that are necessary in order to justify the existence of utility functions.

(1) **Reflexivity**: for any bundle q, $q \geq q$, implying that consumers are indifferent between identical bundles.

(2) **Completeness:** $q^1 \geq q^2$ or $q^2 \geq q^1$ means that consumers can compare any two bundles of goods and state whether they prefer one to another or of they are indifferent between the two.

(3) **Transitivity:** if $q1 \geq q^2$ and $q^2 \geq q^3$ implies that $q^1 \geq q^3$, this axiom allows for indifference curves, which are couture slices of the utility function, to exist. Indifference curves are a set of points where the consumer is indifferent between two goods.

(4) **Continuity**: insures that the indifference curve is continuous and form a closed set.

(5) **Nonsatiation**: a consumer will always prefer more to less of a good, and it implies that utility functions can undergo a positive monotonic transformation and yield a higher level of utility. Since utility is ordinal this axiom only serves to order bundles.

(6) **Convexity**: the indifference curves are convex to the origin. By connecting any two points on the indifference curve, a linear combination line is formed where every point along that line has a higher level of utility then the original indifference curve.

### 2.2.2 Duality and the Properties of Utility Functions

The six axioms allow for the existence of a utility function and leads to the theory of utility maximization. Consumers are assumed to maximize utility subject to their budget constraint, a problem that can be solved by using a Lagrangean function. The first order conditions of the Lagrangean can be used to derive demand functions, and the utility function can be of many different functional forms. The Lagrangean multiplier ($\lambda$) is another value that comes out of taking the first order conditions and it represents the marginal utility of total expenditure (Deaton and Muellbauer, 1980). Utility functions

have some important properties, and this function is usually described as a hill shaped 3-diminsional function if we take the two commodity case. The properties are:

(1). Strict qusi-concavity, this is to rule out horizontal sections on the utility surface, allowing the indifference curves to have accurate optimal tangency points.

(2). The utility function must be increasing in its commodity arguments, insuring that we are on the ascending portion of the function.

(3). The function must be twice continuously differentiable, in order to construct the bordered Hessian matrix which determines if the maximum level of utility is indeed an absolute maximum and to find out the shape of the indifference curves (Chiang 1986).

Duality is an important concept in analyzing consumer choice because it illustrates another way in which the problem of utility maximization can be solved. In order for utility to be maximized the consumer must also be choosing the set of goods that requires the lowest possible expenditure to achieve that level of utility. So the consumer is maximizing utility by minimizing cost.

### 2.2.3 Marshallian and Hicksian Demand Functions

An important implication of this duality principal is that different kinds of demand functions can be derived. If the utility max approach is taken the resulting Marshallian demands are a function of prices and expenditure, and if the cost minimization approach is taken the resulting Hicksian demands are a function of prices and a fixed level of utility. Either of the demand functions can be substituted into their original problems to give maximum utility or minimum cost, resulting in the indirect utility function and the cost function respectively. If the cost function were inverted it would yield the indirect utility function. The cost function also has some properties:

(1) Homogeneity of degree 1 in prices, implying that if prices go up by a certain amount then the cost required to stay at the same level of utility will also increase by the same proportion.

(2) The cost function is increasing in utility, non-decreasing in prices and must be increasing in one price.

(3) Concave in prices

(4) Symmetry, where the cross-price derivatives of the Hicksian demands are symmetric, that is for all $i \neq j$.

$$\frac{\partial h_i(u,p)}{\partial p_j} = \frac{\partial h_j(u,p)}{\partial p_i}$$

(5)**Negativity**, of the substitution or Slutsky matrix, which is a square matrix of the own and cross price effects from the Hicksian demand functions. Negativity and symmetry insure that compensated demand functions are always downward sloping and this allows for non convex preferences. Without these five properties of demand consumers would be allowed to make inconsistent choices. The Slutsky equation allows the substitution matrix to be observable in terms of Marshallian demands.

$$s_{ij} = \frac{\partial h_i}{\partial p_j} = \underbrace{\frac{\partial g_i}{\partial x} * q_j}_{\text{income effect}} + \underbrace{\frac{\partial g_i}{\partial p_j}}_{\text{price effect}}$$

The above equation is set up so that an uncompensated price response is decomposed into an income effect and a substitution effect for a given price change (Pindyck and Rubenfeld, 1999). The income effect can be positive if the good is normal or negative if the good is inferior. The substitution effect is always negative when price

increases. Goods can also be classified as being substitutes if the individual elements in the substitution matrix are positive ($s_{ij}>0$), or complements if ($s_{ij}< 0$).

**2.2.4 Elasticities: Own and Cross Price, Substitution and Expenditure**

Elasticities are important in economic analysis because they convey information on how sensitive a commodity's demand is to price, income, or some other type of variable changes also they are unit less making them comparable across goods . The results can then be used for policy decisions by companies, governments, or any other interested party. Some economists view estimation of elasticities as the primary purpose of empirical demand studies (Deaton and Muellbauer, 1980). Both the own and cross price elasticities of demand are Marshallian elasticities since they are derived from Marshallian demand functions which have price and expenditure as arguments as opposed to price and utility like the Hicksian demand functions have. Some of the most common and important elasticities are:

$$(1)\ e_i = \frac{\partial Q}{\partial P_i} * \frac{P_i}{Q}$$

**Own price elasticity**: illustrates what happens if the price of a good goes up by 1% the demand should fall by a certain percentage. If it goes down by less than $e_i<1$ then the good is exhibiting inelastic demand and can be thought of as a necessity. If the $e_i$ (Deaton and Muellbauer, 1980) >1 then the demand for the good is elastic and can be thought of as a luxury.

$$(2)\quad e_{ij} = \frac{\partial Q_i}{\partial P_j} * \frac{P_j}{Q_i}$$

**Cross price elasticity**: illustrates what happens if the price of another good increases by 1%. If the $e_{ij}<0$ then the goods are gross complements. If $e_{ij}>0$ then they are gross substitutes.

$$(3) \quad \eta = \frac{\partial Q}{\partial I} * \frac{I}{Q}$$

**Income or expenditure elasticities:** tells how much quantity demanded changes with a 1% increase in income.

$$(4) \quad S_{ii} = \frac{\partial P_i}{\partial Q_i} * \frac{Q_i}{P_i}$$

**Own substitution elasticity:** shows the percent change in the price of a good for a 1% increase in quantity supplied. If all of the own substitution elasticities are negative then a demand system satisfies the necessary conditions for negative semi-defiantness requirement.

$$(5) \quad S_{ij} = \frac{\partial P_i}{\partial Q_j} * \frac{Q_j}{P_i}$$

**Cross substitution elasticities:** the main purpose of cross substitution elasticities is to measure the shape of the indifference curve between two goods. The cross substitution elasticities show the degree of complementarity or substitutability between two goods. If $S_{ij}>0$ the goods are net substitutes and the greater the elasticity is away from zero the greater the substitutability. If $S_{ij}<0$ then the goods are net complements.

Many other elasticities can be calculated such as advertising elasticities or those associated with any other variable specified as an argument in the demand function.

## 2.3 How to Model Demand

### 2.3.1 Single Equation vs. Demand System

When people first started to model demand, using time series data, it was often done by looking at commodities individually using a single equation method. It was soon realized that elasticities could be calculated easily if the demand equation was in double-log form. So the parameters of the variables in the function would be for example, the own price elasticity and the parameters of the price variables for closely related goods would be the cross price elasticities. The double-log form could be easily estimated using OLS regression techniques.

Eg. $\log q_i = \alpha_i + e_i \log x + \sum_k e_{ik} \log p_k + u_i$

Although this way of estimating demand is convenient and easy, and it allows for many variables such as seasonal dummies, it does not conform well to economic theory. Homogeneity for example can be tested or imposed a priori but the double log single equation cannot satisfy adding up, unless constant expenditure patterns are observed at all levels of total expenditure (Deaton and Meullbauer, 1980). Another advantage of modeling demands individually is that functional form can be varied to find the best fitting model. Evaluating demands individually may lead to improper results especially if the relationship among goods is dependent. Single equation demand models have had widespread use in business because of their simplicity and because they can be used for the specific need of a business especially for the purpose of calculating elasticity's and forecasting (Johnson, Stonehouse, and Hassan, 1992).

Multi-equation simultaneous econometric models were introduced in the 1970s for business applications but their results were often unreliable and superficial. Today many of these larger models are used by policy makers, analysts, banks etc. Demand systems are also well suited for finding broad trends, and for use in commodity markets where there are complex interrelationships and linkages. They are good at analyzing the impact of policy changes, but large scale models lose credibility when they fail to capture key turning points and misrepresent the direction of key developments. Great care needs to be taken in the model development phase in order to capture many of the smaller differences that might exist in a particular market, and once the model is made ex poste analysis should be conducted to make sure that the models results are robust to changes in the business environment (Johnson, Stonehouse, and Hassan, 1992). Demand systems can be used for forecasting, analyzing marketing strategies, pricing strategies and advertising if they are market goods (Johnson, Stonehouse ,and Hassan, 1992). When Goddard et al (1992) compared a single equation and a two-stage translog demand system on the same set of data for Ontario milk demand, looking at the effects of advertising specifically, it was found that the demand systems approach was superior. The single equation method suffered from weak price effects and an insignificant advertising effect, and serial correlation could not be remedied without destroying the plausibility of the parameter estimates. Even though the demand system turned out better in this particular case it still had restrictive assumptions like weak separability which may not truly represent realistic consumer behavior. Demands for foods and agricultural commodities are being modeled by way of the demand systems more and more because the substitution effects between commodities can not be identified well from the one

equation demand specification. Ad hoc functions are not as good because microeconomic choice theory cannot be tested as it can in a demand system (Johnson, Stonehouse, and Hassan, 1992).

### 2.3.2 Different Types of Separability Including Weak Separability

In order to estimate a demand model, simplifying assumptions are needed to make the estimation easier. The consumer is faced with a seemingly unlimited number of goods on which to spend his money, so there needs to be a way of rationalizing the choice behavior so that not every good needs to be included in the demand system. The first attempts to come up with separable aggregates were made by Hicks 1939, and today they came up with what today is known as the **commodity composite theorem**, stating that commodities can be grouped if their relative prices move together as a fixed ratio relative to a base period. Example $P_1 = \theta P^0_1$ , and $P_2 = \theta P^0_2$, then $\theta$ can be viewed as a price for the combined group. This result had limited usefulness in empirical work because relative prices, especially in an open economy, are independent of the pattern of demand (Deaton and Muellbauer, 1980).

The next step was to try and find ways to partition goods using preferences. A consumer is assumed to have some disposable income which can be spent on goods and services, where the consumer is assumed to spend all his income. According to Gorman (1959) the first step in the budgeting process is to allocate expenditure across broad commodity groups, which is only justifiable if the utility function is separable. The consumer does not need to know the exact prices of all goods, only price indices for different commodity groups and their own income. The assumption is that in each period the consumer is aware of allocations made in past periods, to account for changes in

expected income and prices. Therefore, he does not need to know the indices as long as there is sufficient room for adjustment if the preliminary allocation is wrong, but the errors should not be large from period to period. The utility function must be separable, but also must be additively separable and specific sub-utility functions must be homogeneous, implying that luxuries, near-luxuries, and necessities cannot be grouped together.

If a utility function is separable than the marginal rate of substitution (MRS) between any two items in the same group must be independent of goods in other groups. Homogeneity, implies that the Engel curves must be linear because then an additional dollar spent on a group and the specific commodities within the group depend only on prices of goods in the group (Gorman, 1959). Weak separability is a less stringent assumption, where a utility function is weakly separable from a partition $\{N_1,\ldots, Ns\}$ if the MRS $u_i(x)/u_j(x)$ between two commodities i and j from $N_s$ is independent of the quantities of commodities outside $N_s$ (Goldman and Uzawa, 1966).

$$\frac{\partial u_i(x)/u_j(x)}{\partial x_k} = 0 \quad \text{for all } i,j \in N_s \text{ and } k \text{ is not an element of } N_s$$

Weak separability is an ordinal concept, and its results are generally equivalent to strong separablility (Goldman and Uzawa, 1966). If we have a certain number of goods and if some are related then they can be grouped. When commodities are grouped as sub-utility functions within an overall utility function then we start the construction of a utility tree, where the more disaggregated commodities form the outermost twigs (Deaton and Muellbauer, 1980). The utility tree suggests consumers go through a two-stage or multi-stage budgeting process, where total expenditure is allocated to broad groups in the first

stage, and then in the second stage it is further allocated to individual commodities within a group (Deaton and Muellbauer, 1980). Each of the major branches on the tree can be thought of as a separate utility maximization problem. An example would be to maximize the food sub-utility function subject to the food budget constraint. Weak separability is a necessary and sufficient condition for two-stage budgeting (Deaton and Muellbauer, 1980). A popular type of utility tree is called the S-branch utility tree first analyzed by Brown and Heien (1972). They applied the S-branch system to the LES looking at different food categories. The S-branch utility f(x) is weakly separable with respect to a partition $\{N_1,N_2,\ldots,N_s\}$ if the MRS $(\partial u/\partial q_{ri})(\partial u/\partial q_{rj})$ for $r \neq j$. The S-branch utility function is block additive, so that the MRS between any two goods is independent of any goods in other blocks (Brown and Heien, 1972). This new system was less restrictive than the previous Stone-Geary system because it allows complementary and independent relations as well as substitutes and the own price elasticities lie between 0 and $-\infty$ The main point about utility trees and their implied weak separability assumptions, is that a change in price of a commodity in a group (food) can only effect demand of another commodity in another group (fuel) through the same channel as any other price change of a commodity in that first group (food) (Deaton and Muellbauer, 1980).

Besides weak separability there are other types as well like:

1. direct separability
2. indirect separablity
3. qusi-separability
4. direct pseudo-separability

Pudney (1981) stated that the econometrician is usually faced with the choice of a highly aggregated demand system or a large detailed one that is overly restrictive. He states that

usually a grouping structure is applied a priori and then parameter estimates are generated to test the validity of certain restrictions. However, the sample should be tested to try and come up with the best grouping. The method Pudney used is called **Cluster analysis** and he applies it to the UK National Food Survey data starting from an initial grouping where improvements are sought out by these five steps.

1. the merger of two groups
2. the separation of a single good from an existing group to start a new group
3. the transfer of a single good from one group to another
4. the interchange of two goods from different goods
5. the dissolution of a group into a set of single good groups

When no more improvements can be made then the algorithm has converged to a local optimum (Pudney, 1981). Capps and Havlicek (1984) used USDA 1972-73 cross sectional survey data to analyze the meat group. They used the $S_1$-branch system developed by Brown and Heien but use a generalized LES. They include many socio-demographic variables, branch 1 was the meat branch, 2 was other food and FAFH and 3 was fuels and gasoline. The purpose was to analyze the impact of non-food and FAFH on the demand for meat. Cluster analysis has been used for cross sectional survey data but not time series. Invalid parameter estimates of demand equations can result if the separability restrictions of the consumer are inconsistent with the true preference ordering (Reynolds and Goddard, 1990). In their paper they studied Canadian food demand, using annual data 1960-87, and since the separability restrictions are crucial it merits testing before the results are used. There are two ways to test weak separability (1)**Non-parametrically**, but since these are non-stochastic they implicitly require strong separability of preferences over time. (2) **parametric** tests are stochastic but they depend on the functional form of the utility function. Reynolds and Goddard (1990) used a

parametric testing approach on both the AIDS and Rotterdam systems. Weak separability does not restrict substitutes between goods in the same group, but substitution between goods in different groups occurs only through group expenditure and a factor of proportionality which characterizes the inter-group relationships (Reynolds and Goddard, 1990). They found that meats are separable from all other food groups. Another problem with parametric tests of separability is that a functional form may not allow modeling of different types of separability that the economist might be interested in (Baccouche and Laisney ,1991). Some functional forms like the translog will only allow the restrictions to be imposed locally so a method is needed to describe separability properties globally. This paper checks the sensitivity of different functional forms on weak and implicit separability restrictions. Pudney's approach of using weighted mean square error (WMSE) criterion to test the restrictions has a problem of being conditional on the starting values used. Baccouche and Laisney (1991) replaced the direct search for a partition by choosing among a set of vector $\lambda$ of critical values, each of these vectors lead in turn to a small number of partitions.

Moschini (1992) developed a separable functional form in which all of the relevant aggregation functions are modeled to the desired degree of approximation, producing separable structures that are more flexible compared to the situation where parametric restrictions are placed on flexible functional forms. Tests of separability were conducted in a non-nested framework and the application was to a multi-product translog cost function using a robust likelihood ratio test procedure for model selection on dairy production (Moschini, 1992).

Moschini, Moro, and Green (1994) analyzed US meat demand and comment on separability issues since (beef, pork, poultry) tend to be grouped and demand modeled as a function of price of the three meats and total meat expenditure. Provided that the direct utility function is weakly separable conditional demand functions can be found. However, conditional demands may be undesirable in two aspects, (1) the first stage income allocation is often not specified, making the elasticity estimates of little value (2) though direct weak separability guaranties conditional demand systems, econometric problems still can exist because group expenditure are endogenous (Moschini, Moro, and Green, 1994). The objective of this paper was to illustrate a systematic procedure for maintaining separability restrictions in a full demand system. Being that there are many kinds of separability for example symmetric, asymmetric, direct weak, which means that from the consumer's perspective goods belonging to a sub-utility function can be aggregated into a composite commodity provided that the function is homothetic. Three different types of separability were tested against an unrestricted model. Testing parametric restrictions is often done through a Wald Statistic which only requires estimation of an unrestricted model, but the Wald Statistic has drawbacks so the likelihood ratio test is the best alternative. The likelihood ratio test is good because it is invariant for the non-linear restrictions of separability, but it is biased towards rejection in large demand systems, so a size correction is often needed. They comment on the notion that unconditional elasticities may be better for policy analysis and that if there is concern about simultaneity then it may be more desirable to maintain separability restrictions within a complete demand system (Moschini, Moro, and Green, 1994).

Sellen and Goddard (1996) analyzed US and German coffee demand using annual time series trade data. Weak separability is a necessary and sufficient condition for multistage budgeting, but it also makes possible the use of conditional demand equations theoretically attainable from consumer's utility maximization problem. The objective of the paper was to determine the appropriate commodity aggregation to conduct tests for weak separability within a demand system. Wald statistics or likelihood ratio tests can be used to test weak separability. The Wald statistic has the advantage of being less cumbersome because only the one model (the unrestricted) needs estimation, but its results vary on how the non-linear restrictions are specified. Therefore, the LR test which requires estimation of both the restricted and unrestricted model is a superior test, but they conducted a size correction to prevent over-rejection. Three possible separable structures are selected a priori, and the utility trees are tested to determine whether weak separability is supported. The functional form they choose was the AIDS because of easy estimation and linear Engel curves. The test for separability were only applied at the mean since imposing separability globally is very restrictive, but first the prices have to be scaled and income equal to unity at that point (Sellen and Goddard, 1996).

Weak separability implies that a commodity's sensitivity (chicken) of consumption to income and price changes depends on both the reaction of the whole meat group and changes within the meat group (Edgerton, 1997). The purpose of this paper was to discover the implications of multistage budgeting on the calculation of total expenditure and the total price elasticities, where the formulas are independent of functional form. Edgerton (1997) estimated a dynamic LAIDS using annual time series data from Sweden. An important procedure he conducted was to use two estimation

techniques OLS & SUR. If the error terms in the different sub-systems are block-wise independent of each other then OLS will be asymptotically efficient. The main results were that weak separability assumptions were appropriate and that we cannot restrict ourselves to analyzing the last stage of a multistage budgeting system since this could lead to errors and bad policy decisions could result.

Eales, Hyde, and Schrader (1998) looked at separablity issues in poultry demand specifically. They state that since chicken and turkey demands have been increasing at different rates, combining them or ignoring turkey could be causing bias. Ignoring turkey would require beef, pork, and chicken to be weakly separable from turkey. If we wanted to combine them into a poultry category then they must form a generalized composite commodity, or that chicken and turkey themselves form a separable group and that preferences are homothetic. They found support for the composite commodity therom, and imposing homothetic separability from beef and pork was insignificant. Therefore, turkey can be ignored or grouped with chicken.

Cheney (2001) revisited this issue and argued that turkey should be studied on its own, because it has unique supply and demand factors that seem to oppose aggregation. Since the production cycle for turkeys is longer, producers are not able to adjust to demand shocks as quickly. Although rapid product development in the 70's caused structural change for both chicken and turkey, however turkey consumption is still seasonal, peaking around the holiday season, making it necessary to place higher weights on these months.

In this thesis we would like to assume weak separability at the first stage as a maintained hypothesis because it is necessary and sufficient for multistage budgeting.

The meat group needs to be separable from non-food and within the meat group chicken must be separable from pork and beef in order to estimate some of the more intricate demands for specific products. A few different utility tree structures will be proposed and weak separability could be tested. A problem may surface with fast food consumption of chicken since the structure of the decision making is unclear as to how the consumer decides to eat chicken away from home.

### 2.4 Choice of Relevant Demand Systems

#### 2.4.1 Linear and Quadratic Expenditure Systems

The Linear Expenditure System (LES) was the first demand system that allowed the estimation of demand functions based on economic theory (Stone, 1954). The LES is a system of equations where homogeneity, adding-up, and symmetry can be imposed.

$p_iq_i = p_i\gamma_i + \beta_i(x-\Sigma p_k\gamma_k)$ (LES)

and when applied to a cost function

$c(u,p) = \Sigma p_k\gamma_k + u\Pi p_k^{\beta_k}$

The $\gamma_i$ parameters can be interpreted as a minimum required quantity, or subsistence quantities implying that $(p_i\gamma_i)$ are committed expenditure (Deaton and Muellbauer, 1980). The second component is supernumerary income (X) which is assumed to be positive with no inferior or complementary goods allowed (Stone, 1954). Consumers outlay is in fixed proportions of total expenditure on certain goods, while for the remaining goods they purchase a certain fixed quantity at current prices and then spread the balance of their (X) over the remaining groups in fixed proportions (Stone, 1954). This result in demand curves that show a proportional relationship between

quantities demanded and the price of a commodity under consideration when total expenditure and other prices are held constant and the demand functions have a hyperbola shape (Stone, 1954). The LES does not allow for negative prices or quantities, demand also have to be inelastic if the $\gamma$'s are positive. The LES has an advantage when it comes to the number of parameters to be estimated (2n-1) as opposed to (2n-1)(1/2n+1) allowed for by theory (Deaton and Muellbauer, 1980). The quantities enter the demand function linearly and they should be allowed to vary over time (Pollak and Wales, 1969). One of the simplest ways to do this make quantities a linear function of time by including a time specification and include habit formation by making the equations stochastic where they can be estimated with maximum likelihood (Pollak and Wales, 1969). The basis of the habit formation model is in the idea that consumers either have contractually fixed commitments or that they may be ignorant of consumption possibilities outside their own tastes and range of experience (Pollak, 70). He estimated a dynamic LES with habit formation, and interdependence, where individuals utility is dependent on other peoples past consumption. The marginal budget shares are constant for the LES, and the Allen partial elasticities of substitution between supernumerary quantities are equal to one (Wales, 1971). He estimated a static and dynamic LES with Canadian data 1947-68 where the "marginal budget shares" are the fraction of an additional dollar expenditure spent on each good and are independent of price and expenditure (Pollak and Wales, 1978). Some of the drawbacks of the LES are that in order for concavity to hold all goods must be substitutes (Deaton and Muellbauer, 1980). The model is linear in the variables but not in the parameters $\gamma$ and $\beta$ and it belongs to a class of demand models which share the property of proportionality between price and

expenditure elasticities, which often makes the model too restrictive (Deaton and Muellbauer, 1980).

The Quadratic Expenditure System (QES) is a demand system that is quadratic in expenditure and it nests the LES as a special case, if marginal budget shares are independent of expenditure, and it allows the marginal budget share MBS to vary with both price and expenditure and it allows the marginal budget share MBS to vary with both price and expenditure (Pollak and Wales, 1978).

$$w_{it} = \frac{p_{it}\alpha_i}{y_t} + \beta_i\left(1 - \frac{p_t'\gamma}{y_t}\right) + \left(\frac{p_{it}\delta_i}{y_t} - \beta_i \frac{p_t'\delta}{y_t}\right) \prod_{i=1} \left(\frac{p_{it}}{y_t}\right)^{-2\beta} \left(1 - \frac{p_t'\gamma}{y_t}\right)^2 \quad \text{(QES)}$$

They found that the (QES) is significantly better than the (LES) according to the likelihood ratio test on UK household budget data study (Pollak and Wales, 1978).

**2.4.2 Rotterdam Model**

The Rotterdam model is different from the LES because it works with differenced data instead of levels of logs (Deaton and Muellbauer, 1980). The Rotterdam provides a first order Taylor series approximation to a theoretical system of equations (Barnett, 1979). In many ways the Rotterdam is similar to other flexible forms like the translog, but the underlying assumptions are weaker than the demand system of a representative consumer like in other flexible forms. In the Rotterdam the expenditure and price elasticities are not constant like they are for the LES (Deaton and Muellbauer, 1980). Authors like (Shonkwiler, 1993) have used the Rotterdam in meat demand studies including structural latent variables. He analyzed meat consumption to see if structural change occurred in US meat demand noting that many previous studies have been sensitive to functional form. His main argument was that when non-stationary time series data is used with an AIDS model (in levels form), where a time trend and/or other strongly trended variables are included, a spurious regression can result (Shonkwiler,

1993). Since the Rotterdam uses differenced data and if the price and income effects are difference stationary then the Rotterdam will provide a first degree Taylor approx to the existing demand system. The two trends he tested were health concerns over cholesterol and a convenience index are included using annual data 1956-87. The results reviled that beef and pork were luxuries and that poultry is a necessity. On the convenience issue they found an increasing FAFH trend and that both health and convenience concerns are shaping consumers change in tastes and should not be ignored in a demand model. Shonkwiler (1993) also found that beef demand decreased 11%, pork 4%, but poultry demand increased by 57% implying that poultry consumption increased more than the taste induced change because of the relative price of poultry compared to other meats over this period. The Rotterdam measures Hicksian demand since it measures change in utility just like the LES (Deaton and Muellbauer, 1980).

$w_i \, d \log q_i = b_i d\log X^{bar} + \sum_j c_{ij} \, d\log p_j$ (Rotterdam)

The $b_i$'s represent the marginal propensity to consume (MPC), where the above equation can only be estimated if the $b_i$'s and the $c_{ij}$'s are constant parameters (Deaton and Muellbauer, 1980). Also in order for adding up to be satisfied the $\sum$MPC's =1 so that the net effect of a price change on the budget is zero. Symmetry and negativity can be tested. The Rotterdam was an improvement from the LES because it allows the substitution matrix to be estimated when it is only required to be symmetric, therefore it is possible to identify substitutes and complement goods (Deaton and Muellbauer, 1980). However, the model cannot have constant b's and c's unless all the total expenditure elasticities are equal to one, and that the own price elasticities are -1 with all cross price elasticities equal to zero (Deaton and Muellbauer, 1980). Since it is an unrealistic assumption that

they would be constant, we cannot use the model to represent a single consumer (Deaton and Muellbauer, 1980). Kinnucan et al (1997) used the Rotterdam to study the effect generic advertising and health information has on US meat demand using time series data from the USDA. The advertising variables were included as a shift variable and the model was estimated using SUR since no correlation was found between price, expenditure, and the error terms. They found that poultry consumption was more sensitive to health information than to own price or changes in beef's price. Brester and Schroder (1995) used a Rotterdam model to analyze both brand and generic advertising on meat using quarterly data 1970-93. They also used an absolute price version of the model; they assume that advertising is a scaling variable since if advertising is assumed to affect the demand elasticities the scaling introduces indirect price effects generated by the advertising expenditure. Advertising can have a shifter effect on demand but it can also have a translating effect resulting in psychological needs or substance requirements of products generated by advertising (Brester and Schroder, 1995). It is important to remember that the Rotterdam is only an approximation and that it is not a flexible functional form, and it is not globally valid (Deaton and Muellbauer, 1980).

### 2.4.3 Translog Model

The translog (TL) is a flexible form and can be used to approximate a direct, or indirect utility function or a cost function, and it is an approximation to whatever the true unknown function is (Deaton and Muellbauer, 1980). This model was first developed by (Christensen, Jorgenson, and Lau, 1975) and it is a consistent system of demand with regards to utility maximization. An example of a translog approximation of an indirect utility function is:

$u = \Psi(X,p) = \alpha_0 + \sum_k \alpha_k \log (p_k/X) + \frac{1}{2} \sum_k \sum_j \beta_{kj} \log (p_k/X) \log (p_j/X)$

They wanted to develop a system that did not use additivity and homogeneity as a maintained hypothesis. By letting the utility function be quadratic logs of the quantities consumed, it made the system a 2nd order approximation to any utility function. It allows expenditure share to vary with the level of total expenditure and allows for a greater variety of substitution patterns among commodities compared to systems like the LES (Christensen, Jorgenson, and Lau, 1975). A second objective was to use duality in estimating both a direct and indirect utility function so they also ended up estimating an indirect utility function quadratic in the logs of prices and total expenditure like the above equation. This indirect utility function is additive and homothetic, implying the ratios of the direct demand functions depend only on the ratio of prices (Christensen, Jorgenson, and Lau, 1975). Tests of the restrictions of additivity and homotheticity are conducted for the indirect trans-log utility function. Their conclusion was that the theory of demand was inconsistent with the evidence, or that the theory is valid but utility is not linear logarithmic, but the results rule out this last possibility. They find that additvity of the utility function occurs only if the direct utility function is homothetic. The translog has an advantage over the Rotterdam of providing a better understood approximation (Barnett, 1979). The $\Psi(X,p)$ or indirect utility function is homogeneous of degree zero which allows the use of the ratios of p to X rather than the variables themselves (Deaton and Muellbauer, 1980). The translog is still an approximation to a underlying utility function which implies that it is only trusted accurate at a local point, and at particular values of price and income ratios (Deaton and Muellbauer, 1980). Deaton and Muellbauer (1980) go on to find that the translog's results do not differ from the Rotterdam model that

much, and they criticize the model for having demand functions which are complicated and clumsy to estimate and for estimating the model under the assumption that goods prices are determined by quantity's and not the other way around.

**2.4.4 AIDS Model**

Deaton and Muellbauer (1980) estimated the Almost Ideal Demand System (AIDS) model which is a demand system that assumes utility maximization and is a first order approximation to any demand system. It's advantage over the Rotterdam and translog is that it aggregates over consumers without having parallel linear Engel curves, and homogeneity and symmetry can be imposed through linear restrictions on fixed parameters (Deaton and Muellbauer, 1980). The model looks like this:

$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log (X/P)$ where P is a price index

$\log P = \alpha_o + \sum \alpha_k \log p_k + \frac{1}{2} \sum_k \sum \gamma_{kl} \log p_k \log p_l$

$\gamma_{ij} = \frac{1}{2} (\gamma_{ij}^* + \gamma_{ji}^*) = \gamma_{ji}$

The restrictions that apply to the parameters are:

(1) Adding-up: $\sum_i \alpha_k = 1$, $\sum_i \beta_k = 0$, $\sum_i \gamma_{kj} = 0$
(2) Homogeneity: $\sum_i \gamma_{ji} = 0$
(3) Symmetry: $\gamma_{ij} = \gamma_{ji}$

Since the AIDS is almost linear in this form the equations can be estimated one at a time using OLS (Deaton and Muellbauer, 1980). The (P) in the equation will be proportional to any price index if prices are collinear, and the index can be estimated before estimation, a direct difference from the translog (Deaton and Muellbauer, 1980). The $\beta$ parameters tell if the good is a luxury or not, eg. if $\beta_i > 0$, expenditure share $w_i$ will increase with expenditure implying that the good is a luxury, if $\beta_i < 0$ expenditure share $w_i$ decreases with expenditure implying that the good is a necessity. The $\gamma_{ij}$ parameters are

the own and cross price effects and represent the change in the $i^{th}$ budget share following a unit proportional change in $p_j$ while (X/P) is constant (Deaton and Muellbauer, 1980). This implies for unrelated goods the own and cross price elasticities are <0 leading to the observation that as the range of possible substitutes increases so will the price responses (Deaton and Muellbauer, 1980). A weak relation was also found between price and expenditure elasticities probability because there are few substitutes for necessities, and a large number for luxuries. The AIDS is certainly less restrictive than the LES, but like the Rotterdam and translog, in empirical use homogeneity and symmetry can be rejected (Deaton and Muellbauer, 1980). They conclude their landmark paper by stating that AIDS provides the platform for looking at other factors other than price to explain demand. Brenton (1994) analyzed the AIDS model for application to trade studies using European time series data. He argued that a demand system can only produce consistent estimates if it satisfies homogeneity, symmetry, adding-up, and negativity. He looked specifically at the negativity problem and states that if negativity is imposed the functional form will no longer be flexible. Models like the AIDS & translog may not be globally negative, by imposing negativity on the price coefficient matrix, the Slutsky matrix eventually becomes negative semi-definite, resulting in increased standard errors on the estimates making them useless for welfare studies (Brenton, 1994). The problem with using a globally flexible AIDS is that it contains trigonometric functions making it over-parameterized.

### 2.4.5 Linear Approximate AIDS (LAAIDS)

Often elasticities are important results that one wants from estimating these models. Green & Alston (1990) compared elasticities from an AIDS and a linear approximate AIDS model (LAAIDS).

$\ln P^* = \sum_k w_k \ln P_k$

$w_i = (\alpha_i - \beta_i \ln \zeta) + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln (X/P^*)$ (LAAIDS)

The LAAIDS differs from the AIDS because it used Stones (geometric) price index ($P^*$) instead of P. If prices are highly collinear then P & $P^*$ could be proportional; however they are not nested systems. If the P is exactly linearly proportional to $P^*$ the LAAIDS can be used to estimate the AIDS parameters (Green and Alston, 1990). This papers main message was to use the correct elasticity formulas, when estimating an AIDS use the AIDS price elasticity formula, otherwise the elasticities may be incorrect and errors could result. Alston, Foster and Green (1994) looked at the LAAIDS increasing popularity and tried to answer the question on when it is justified to use the linear approximation to the AIDS. They established that it depends on the parameters and the collinearity of the exogenous price variables that determine the accuracy of the estimates. It is very important on how well the Stone index approximates the AIDS price index, they generated the data using Monte Carlo and the LAAIDS was estimated using SUR by 3-stage least squares. The main conclusion of the paper was that different elasticity values can be obtained from the AIDS model when LAAIDS parameter estimates are substituted into the elasticity expression, usually resulting in poor estimates especially when there is a high level of muticollinearity in prices. The best results occur when we assume that the budget shares are endogenous on the RHS of the demand equation or when they are

assumed constant. Another finding was that the LAAIDS provides reasonably accurate estimates when the true data generating process is AIDS (Alston, Foster and Green, 1994).

Chua et al (2001) compared an AIDS and a translog with the objective of using a Bayesian framework to test inequality restrictions imposed on the system to achieve monotonicity and concavity. Their argument is that when one chooses a functional form it may be incorrect, and Bayesian averaging similar to that conducted by Geweeke (1999) gives results that measures model precision and reflects the model uncertainty. This is a type of weighting technique where the models results are combined as a weighted average; where the weight attached to each model is the posterior probability that the model is actually correct. If one model appears greatly superior its probability will be close to one, and its results will be close to the best fitting superior model. They conducted this method on an AIDS and Translog looking at quarterly meat consumption data in the USA, 1979-1995. When the models were evaluated at their mean price and expenditure, there is no difference between the two using averaging. However, at points away from the mean the Bayesian technique did impact the inferences. A major difference occurred with income and price elasticities for poultry between the two models at points away from the mean. The results of the averaging seemed to favor the AIDS model since it had a higher probability at that particular point (Chua et al, 2001).

Dameus et al (2002) compared a first difference AIDS (FDAIDS) and a Rotterdam looking at US meat demand. They used a cox test with a parametric boot strap to test the difference between the two models. The cox test is based on the log-likelihood of the two models, and a parametric bootstrap is used to estimate the distribution of this

test statistic under the null. This is a non-nested test for choosing between demand systems, but the condition is that one model cannot be a special case of the other. They compared the results to an encompassing test which uses a composite model formed as a linear combination of the two models in a null and alternative hypothesis. The results showed that with an updated dataset the Rotterdam is favored to the FDAIDS. The combined model was worse than the Rotterdam and the cox test rejected the FDAIDS and failed to reject the Rotterdam for all datasets studied. The cox test is a more powerful test compared to the encompassing test (Dameus et al, 2002). Many of the newer types of demand models are nested systems where one model may nest others as special cases. One of the important recent examples is the Lewbel model which is a combination of the AIDS and the Translog (Lewbel, 1989). When he used this model to study general commodity demand in the US he found that the AIDS and Translog are about equal in statistical power but the joint model was slightly superior. However, since the difference was small the resulting elasticity estimates from the joint model were similar to the others. He still found some aggregation problems over total expenditure and presented some solutions to the problem, but all models failed to satisfy concavity at smaller price and expenditure levels. Still this is a good model to use if you want to test both demand systems anyway.

### 2.4.6 PIGLOG Demand Systems & Rank Three Demand Systems.

Nicol (1996) estimated a Price Independent Generalized Logarithmic (PIGLOG) demand system using Canadian expenditure data from 1969-92 from the Family Expenditure Survey public use data files. The PIGLOG is a rank three demand system and produces quadratic logarithmic budget-share demand systems. This is a nested model

and contains many other forms as special cases like the AIDS. He estimated five different models using both nonlinear 3-stage least squares and maximum likelihood (ML), and models were parameterized to test the exact aggregation hypothesis and separability of demands from labor and other goods. Exact aggregation and separability of demands was rejected and household characteristics were found to be important in determining demand. Homogeneity and symmetry held independent of the estimation technique. Exogeneity, of the explanatory variables was rejected for the restrictive models but not for the most general one, which relaxed the exact aggregation and included labor force variables. An important point to remember is that models with demographic effects interacting with income are not exactly aggreble.

Piggott (2003) estimated a nested-PIGLOG model which contains thirteen different demand systems applying the model to US food demand specifically the food at home (FAH) vs. food away from home (FAFH), and alcoholic beverages. This nested model allows for comparison of competing functional forms using hypothesis tests, and illustrates how elasticities are affected by the generalized model. The PIGLOG has the desirable property of allowing exact aggregation over consumers. The new demand system is consistent with PIGLOG preferences for supernumerary expenditure or total expenditure if pre-determined quantities are not permitted. He applied this model to aggregate annual time series data 1968-99, and as a maintained hypothesis food is weakly separable from all other goods. He found that food expenditure has been decreasing as a part of personal disposable income. More general models seem to be less consistent with curvature over the sample period; he found that less generalized models satisfy curvature globally as compared to general models, which may be less consistent with demand

theory. Using out of sample forecast accuracy can also be used as criteria to compare models to see which one is preferred. They find that more general models produce more accurate out of sample forecasts, and since estimated elasticities by different models can be "fragile", selecting the wrong functional form can lead to bias. When selecting a demand system it must be flexible enough to represent a wide range of price and income responses which allows it to better project consumer demand and lead to better results for policy analysis (Cranfield, 2003). He compared five different demand systems:

1. An Implicitly additive demand System (AIDADS)
2. Quadratic Almost Ideal Demand System (QUAIDS)
3. QES
4. LES
5. AIDS

Comparisons are made between these models using cross-sectional data from different countries. The problem was he needed a system that could accommodate widely fluctuating expenditure levels and could capture non-linear Engle effects. The AIDADS:

$$w_{it} = \frac{p_{it}\gamma_i}{Y_t} + \frac{\alpha_i + \beta_i \exp(u_t)}{1+\exp(u_t)}\left(1 - \frac{p_t'\gamma}{y_t}\right) \quad \text{for each and every i,t}$$

is a rank 3 demand system with utility in the arguments, making it cardinal. However, this system is very parsimonious. Lewbel defined the rank of a demand system as "the maximum dimension of the function space spanned by the Engle curves of the demand system." Rank is useful in developing a taxonomic classification system for demand models based on Engle curve shape.

Rank 1 = independent of income, most restrictive

Rank 2 = less restrictive, allowing linear Engle curves but not necessary through the origin

Rank 3 = least restrictive allows for non-linear Engle responses

Cranfield (2003) used a RMSE test to find the best model in terms of in sample predicting power, where the heaver parameterized models should fit the best. He ranked the systems in terms of best in-sample predicting power as:

(1) QUAIDS
(2) AIDADS
(3) AIDS
(4) QES
(5) LES

Then he used a system wide RMSE test to evaluate out of sample performance and the results were:

(1) AIDS
(2) AIDADS
(3) QUAIDS
(4) QES
(5) LES

Out of the rank three demand systems the QUAIDS specified by the following equation:

$$w_{it} = \alpha_i + \sum_{i}^{n}\ln(p_{it}) + \beta_i\left(\frac{y_t}{P_t^*}\right) + \lambda_i\left(\prod_{c=1} p_{it}^{\beta_i}\right)^{-1}\left[\ln\left(\frac{y_t}{P_t^*}\right)\right]^2$$

scored the best since it is exactly aggreble and allows for flexible income effects. However it is the AIDS model, a rank 2 system where expenditure are allowed to vary linearly in the log of expenditure and performs the best overall for out of sample predicting power. Generally we can see that perhaps the more disaggregated the commodities the simpler the demand system the better it performs. When aggregation is broader larger nested models seem to predict demand better and more realistically than

smaller more restrictive models. The decision on which functional form to use will eventually come down to a matter of individual choice and the particular application. Sometimes different forms can be tested and the one that fits best is chosen or an estimated form can be checked against another to see if the results are robust.

**2.5 Food Away From Home (FAFH) and Prepared Foods**

One of the most important areas of chicken consumption in the last thirty years has been in the food away from home market. In Canada approximately 42% of the chicken consumption is done away from home (CFC, 2003). In 2002 chicken was rated by the Canadian Restaurant and Foodservices Association (CRFA) as one of the top ten ordered foods representing 10% of all eating out occasions, as well products like chicken nuggets and strips are growing in popularity (CRFA, 2003). Household production theory offers the necessary background to understand why individuals and families eat out. The basic concept of household production theory and its application to FAFH consumption is that households have to be viewed as both a consuming and producing unit (Deaton and Muellbaur, 1980). When the household produces a good like food it uses market purchased inputs and time, where households maximize the utility from the production of non-market goods.

Prochaska and Schrimper (1973) were one of the first to analyze FAFH consumption in the US, their hypothesis was based on the opportunity cost of homemaker's time and how it was thought to have a positive impact on FAFH consumption by employed homemakers. They used 1965-66 USDA household consumption survey data, where the model includes a utility function, a household production function and a time constraint, with a linear regression model. The dependant

variable in the study was the number of meals eaten away from home. Results indicatde that as family income increases more meals are consumed away from home and expenditure elasticities were higher for urban households and lowest for rural households. People with more income tend to spend more on quality and service which translates into higher priced meals. The main result was that the employed have a higher opportunity cost of time and consume more food away from home than households who have a lower opportunity cost of time, they calculated a "value-of-time" elasticity which represents a percentage change in the number of meals eaten away from home due to a 1% increase in the value of the homemakers time. The more pre-school children in the house the less FAFH is consumed, and the more adults in the home the more is consumed. The value of homemaker's time was derived using an alternative market wage rate, but they comment on this method by saying that it would be better to find a more direct method. The opportunity cost of time may be changing due to increased availability of convenience food and labor saving kitchen equipment which can lower the amount of time and the opportunity cost of a meal prepared at home.

Sexauer (1979) studied FAFH in the US and includes the possibility of demographic shifts and income distribution changes in consumer demand. By ignoring these possibilities it could impact the income and price elasticity estimates, also long run projections could be negatively affected as well. The study attempted to quantify the degree to which aggregate expenditure on FAFH depends on income distribution and household characteristics. They used 1972-73 USDA survey data with a linear functional form and estimate with OLS. Income was a continuous variable and annual expenditure on FAFH by each household was the dependant variable. Examples of socio-

demographic variables include age, sex, household size, and urbanity. Some of the main findings are that urban college educated under 65, male households with a working wife spent the most $880 per year on FAFH. In contrast to rural, single, less than college educated, females who spent the least at $56/yr. He calculated a Marginal Propensity to Consume (MPC) for each subgroup in order to disaggregate the income effect. Conclusions are drawn stating that behavioral differences that economists sometimes attribute to changing tastes may actually be compositional shifts, and ignoring these and income distribution shifts can lead to specification bias.

Kinsey (1983) used a Tobit model to estimate MPC for FAFH and found that the level of income earned by full time working wives did not increase the MPC. In the US from 1954-78 real expenditure on FAFH increased eighty percent, and FAFH as a proportion of total food expenditure increased from 25% to 38%. The result is that food distribution is being changed due to higher real incomes and location of the restaurants. He argued that the wage rate of the homemaker is not as important as the actual time they have available for cooking. Presumably FAFH is less time intensive so people who work more hours will have a higher marginal value of time which causes them to eat out more. He found that if the homemaker worked part time it increased MPC by $0.25, the largest increase. He argued that full time working wives which are under tremendous time constraints are willing to substitute full service FAFH with quick service food or prepared food items that are easy to prepare at home, explaining why full time working wives expenditure causes no increase in FAFH consumption. Income elasticities are <1 implying that FAFH does not seem to be a luxury good for most families.

McCraken and Brandt (1987) looked at US FAFH consumption by type of facility; they used cross sectional USDA survey data and estimated a tobit model. Income, time, family size and composition are all important determinants of FAFH consumption but the importance of these factors varied by type of facility. Three different types were studies (1) conventional restaurant (2) fast food (3) other commercial. They found that the proportion of dollars spent at fast food restaurants is increasing; these trends along with expanded menu selection are going to impact the food distribution system and ultimately farm level demand. Some of their findings indicate that expenditure is affected by household income, but the value of household time had a positive effect on fast food and other commercial expenditure but only a marginal effect on restaurant expenditure. In a sense capital is substituting for cooking labor and as long as purchasing FAFH produces the food faster than making it your self this trend is expected to continue. The income elasticity at restaurants and commercial facilities were 0.34 and 0.36, but fast food only had 0.04 income elasticity. If household income increases expenditure at restaurants and commercial facilities also increases, but people will not spend more at fast food restaurants. Therefore, the fast food industry should concentrate its efforts on targeting people who previously did not eat FAFH and on middle income groups. The Tobit regression is used to overcome the zero expenditure problems in survey data.

Horton and Campbell (1991) analyzed FAFH in Canada, using 1984 Family Food Expenditure Survey data, and estimation was done with OLS. They included a cost per calorie variable as well as a food share of income and nutrient availability variable. They found that with higher incomes people eat more at restaurants but nutrient intake is a

potential concern since households with the lowest per capita calorie intake are those where the wife works. Engel's law seemed to hold because higher income households have a lower budget share on food, but a shift also occurs to more costly types of food.

Reynolds and Goddard (1993) studied expenditure on Canadian FAFH by type of meal and facility. They argue that since certain foods are typically consumed around certain meals, modeling food away from home by type of meal could be useful, the study used a Tobit model with survey data. There are many reasons why a household may want to substitute FAFH for food at home (FAH), for example entertainment or leisure, convenience, and food variety. Establishment type will be an important factor with regard to the primary motivation for eating out. To avoid the zero expenditure problem the Tobit model was specified so that observed expenditure is equal to desired expenditure if desired expenditure is positive, otherwise zero expenditure is observed. They found that on average a Canadian household spends $46/ week on FAFH (56% table, 25% fast food, 11% cafeteria, 7% other), and expenditure on meal type broke down (49% dinner, 15% lunches, 12% between meals, 7% breakfast). The income elasticities were positive implying that FAFH is a normal good.

Yen (1993) analyzed FAFH consumption in the US using BLS 1989 consumer expenditure survey data and estimating a double hurdle model. He determines that the double hurdle model is better than other models typically used in these types of studies such as the Tobit because it is less restrictive since the variables and parameters that determine the consumption level also determine the decision to consume. The model refutes the evidence found by other studies that suggest working wives consume less FAFH because consumption also takes time. His results suggested that higher income,

larger older white households living in the northeastern US as well as families with busy working wives consume more FAFH. The model also suggests that older households are less likely to eat out but once the decision to consume has been made this demographic will spend more at expensive restaurants. This finding may have important implications for the Canadian market as well since much of the baby boom generation is getting older, the type of restaurant and the amount they spend may change and have positive effects for more formal sit down restaurants and a negative effect on fast food establishments. It may be wise for the chicken industry to take these emerging trends into consideration for future marketing strategies.

Nayga (1996) studied poultry demand specifically using a discrete choice Logit model on survey data looking at both at home and away from home purchases. The dependant variable is probability of consuming poultry away from home is Prob=1, Prob=0 if not. The independent variables include urbanity, race, Hispanic, sex, weekend consumption, household size, and other factors. The study uses USDA Nationwide food consumption survey data for the years 1987-88, the model predicted well and had an 87% success rate in correctly classifying households as either consuming or not. The model points to urbanization, region, and race as significant variables affecting consumption. City households are more likely to eat poultry at home than people in rural areas. Whites were less likely to eat poultry both at home and away from home, also employed individuals were more likely to eat poultry away from home, and the more people living in the household the less likely they are to eat out.

Besides eating FAFH the retail industry has responded by offering products that do not take much preparation time at home. Chicken is no exception, many stores offer

cooked ready to eat chicken or more commonly chicken that has been cut and seasoned which reduces preparation time. Nayga (1996) explained that the homemakers preparation time is important so he classified food expenditure into three types (1) food prepared at home (2) prepared foods (3) FAFH. Hypothesizing that substitution occurs among the three types he analyzed the effect of wife's employment on FAFH and prepared food expenditure. 1992 consumer expenditure survey data was used to look at weekly expenditure on the three types. Prepared food was defined as food purchased at retail stores and does not take much time to cook (frozen meals, prepared salads). He used a probit model, estimating a system of equations using a generalized Heckman two-step procedure. In the first step the decision is made to buy or not, the second step a system of expenditure equations were estimated with SUR. The results showed that the number of children is positively related to expenditures on food prepared at home. He found that families with home mortgages spend more both on home prepared food and FAFH, indicating that home mortgages do not necessarily decrease expenditures on FAFH. When looking at prepared foods, northeastern families spent the most, compared to Midwestern and western families, but southern families spent the least. Higher educated women spent close to a dollar more than less than high school educated women on prepared food. College educated wives spent $11.35 per week more on FAFH than do lower educated wives and the more time the wife spent at work the more the family will expend on both prepared food and FAFH. The expenditure elasticity with respect to wife's labor hours per week indicated that increasing the number of hours worked had a greater effect on FAFH than on prepared food. Income elasticities were 0.111 & 0.316 for food prepared at home and FAFH respectively, so home made food is less responsive

to income changes. Wife's labor hours were found not to effect expenditure on home prepared food but it positively affects expenditure on the other two. As more women become educated and enter the workforce families will continue to spend more on prepared & FAFH, but the effect will be greater on FAFH. Prepared food marketers need to focus on this demographic group to stay competitive. He suggested using scanner data to look at disaggregated prepared food to analyze more detailed consumption patterns.

Jensen and Yen (1996) noted that one aspect of FAFH consumption that has not been analyzed in the US was different types of meal purchases. The dependant variable was household purchases on breakfast, lunch and dinner away from home for a two week period. They used a double-hurdle model, which separated the participation and consumption processes. One challenge with the double-hurdle model is selecting first and second hurdle regressors because theory is of little help and the number of variables can be limited. The more seniors in the family the lower the probability of consuming all types of meals away from home, however once the decision to eat out has been made, the effect of this variable on the conditional level of lunch away from home was significant and positive, implying that older members in the household increase expenditure on lunch away from home. Working aged people had a positive significant effect on the conditional level of lunch expenditure, but a negative effect on the probability of eating dinner out. This reflects that working people are willing to eat out at lunch since most are out working during that time of day anyway, and work functions may make them predisposed to buying lunch, for example business meetings or the proximity of food service establishments. Of notable significance is that better educated families consumed more FAFH across all meal types and also spend more per meal. White households also

had a higher probability of consuming dinner and breakfast away from home, and consumed more overall as well. The results indicate that there is potential for increasing lunch away from home services, and that convenience food for slight home preparation may be more suitable for households with children. Take out foods are a popular new concept where people can get FAFH without going through the time consuming process of sitting down at a restaurant. Differences in the FAFH market are clearly evidenced by this paper and the demand for FAFH changes by time of day and meal type.

Byrne, Capps and Saha (1996) conducted a probit analysis using NPD survey data 1982-89, to study the effects of socio-economic and demographic variables both on the decision to consume and how much to spend. They used a Heckman two step approach where the decision to consume is broken down into a participation and a level of consumption or expenditure decision. If an inverse Mills ratio was significant which is (the ratio of the value of the standard normal density function to the value of the standard normal cumulative distribution function) then sample selection bias exists. Marginal probability elasticities (MPE's) are calculated with respect to the selected independent variables. The results showed that the number of hours worked by the household manager had a significant and positive effect on the probability of eating out. People who lived in cities have higher MPE, and income has the highest MPE of all the variables. They found that people living in the Midwest and south have a higher probability of consuming FAFH but people in the North East have higher expenditure levels, which is consistent with other studies. An interesting finding was that households that only purchase FAFH on the weekend spend on average $6-8 more than households who only consume FAFH on weekdays. Fast food marketers have increased their marketing efforts on younger

household members possibly explaining their rise in relative contribution. They found a fairly constant income elasticity of about 0.20 and that there is inelastic demand for FAFH. Household size does effect FAFH consumption, where younger members contribute less than adults, but their contribution is increasing.

Park and Capps (1997) analyzed prepared food purchases at the grocery store and FAFH in the US. The share of retail food sales has decreased in the last few decades as a response to decreased sales many stores started offering prepared food where the buyer just needs to cook it for a short period of time or the food might already be pre-cooked. In the US 30% of supermarkets have a format which accommodates prepared food, allowing consumers to transfer food preparation time and skill to processors and retailers. In the marketing of prepared foods retailers have to be able to predict demand with a high degree of accuracy since any left over product results in added cost. The eventual goal would be that elasticities be calculated for specific food products allowing for more targeted promotions resulting in profit maximization and enhanced consumer satisfaction. In their analysis products were classified as (1) unprepared (2) semi-prepared (3) prepared thereby taking into account the household mangers opportunity cost of time. They also note the importance of classifying items as snacks, meal components, or complete meals. Within the prepared meal group products were further disaggregated as either ready-to-cook or ready-to-eat. FAFH and all other food made at home (except prepared meals) may be substitutes or complements for prepared meals. Using OLS with probit regression on 1987-88 nationwide Food Consumption Survey data, some of the more interesting results are summarized on the following table:

Table 2.1 Demographic Characteristics Affecting The Probability of Prepared Meal Consumption.

| Variable | Effect on Probability of Prepared meal Consumption |
|---|---|
| Income | + |
| Household size | + |
| Opportunity cost of time | + |
| Male manager | + |
| Microwave | + |
| Older manager | - |
| Younger manager | + |
| Suburban | + |
| Rural | - |
| Urban | - |

Source: Park and Capps 1997.

The ready-to-eat (RTE) meals were more price responsive than ready-to-cook (RTC) meals, but the RTC meals were more responsive to changes in income. Since the effect of FAFH price changes were positive for all the regressions prepared meals and FAFH are substitutes. Younger more educated household managers, or managers with considerable time constraints were more likely to consume prepared food. Prepared food was a complement for all other food consumed at home, Own price elasticity's for prepared foods was (-0.3744) and income elasticity was (0.1317). A trend in the 90's was for supermarkets to focus on perishable and fresh produce departments and in prepared meals in order to compete with other stores especially on quality. Freshness, convenience, healthfulness are all factors retailers should consider in developing prepared food and if it is done correctly it can provide higher than average profit margins. Scanner data is good, however it does not usually come with demographic information however, frequent shopper cards and other consumer tracking devises may help fill the void.

Without a doubt FAFH consumption has an effect on food processors and retailers in many countries around the world (Mihalopoulos and Demoussis, 2001). Food items that require less preparation time continue to be popular with consumers as long as quality of the food is good. However, this industry requires a continuous supply of high quality agricultural products and will most likely help increase contract farming and other arrangements that will increase the involvement of food processors in farmers input decisions (Mihalopoulos and Demoussis, 2001).

Statistics Canada does not keep track of which restaurants buy chicken and how much is bought, they only keep track of aggregate consumption and approximately how much goes to the food service industry in general. Marketing boards probably have data on the distribution of sales to the food service industry but the complication arises in obtaining a price index of food away from home. A set of fast food industry prices is needed over the same period as the Nielsen data to make sure all of the chicken disappearance in Canada is being accounted for. In attempting to compare between the AC Nielsen data we can look at Table 2.2 which illustrated the percentage share of birds slaughtered in different weight classes. The CFC has clamed that the restaurant industry only purchases lighter birds but from the slaughter figures it is not possible to tell how much many birds are going to the restaurant industry.

Table 2.2 Percentage Share of Chicken Slaughtered Based on Weight Class for 2003.

| Weight Range (kg eviscerated) | Number of Head | Percent Share of Slaughter |
|---|---|---|
| <1kg | 3331494 | 0.01% |
| 1kg-2kg | 564721800 | 94% |
| >2kg | 31356522 | 0.05% |
| Total | 599409814 | |

Source: Agriculture Canada Poultry Market Review 2004.

Correlation between the AC Nielsen data and the PMR data is at **0.4097** which suggests only a small positive correlation. Possible improvements could involve delving into the PMR historical files and sorting out part by part the slaughter, export, and import, this would probably increase the correlation and the estimate of how much the food service industry is taking. The best solution would be to find data on the exact quantity and price of chicken away from home over the same period as the AC Nielsen data. The demand for different types of products like white meat vs. dark meat is also complicating restaurant demand since white meat demand is much higher than the demand for dark meat so the industry requires a considerable amount of white meat. The restaurants themselves do not have scanners for their meals so the only way to get specific information is to ask the companies directly for the information. The FAFH market is important in aggregate chicken demand but the thesis will narrow the focus on the demand for disaggregated retail products which is still the dominant way that chicken is sold in Canada.

### 2.6 Previous Meat Demand Studies

Before chicken demand can be studied at a disaggregated level some background must be given of previous chicken studies. Chicken is often included within more general meat analysis papers. The reason that the meats are usually studied together is because they are thought to be close substitutes or because the study uses a high level of aggregation. One of the main goals of meat demand studies is to calculate important elasticities like own-price, cross-price, and expenditure. If advertising information is available then advertising elasticities can be derived to give an indication of how effective the level and type the promotion is. Basically, the importance of elasticities is to

provide useful information to policy makers, however, politicians and law makers are not the only groups benefiting from this type of information. Agricultural product marketing agencies which exist for almost every type of farm product have an interest in knowing as much about the demand side of the market as possible to assist with product development and promotion. Processors and retailers benefit as well but if the level of aggregation is too high then the usefulness may be limited. Meat demand studies have evolved over time through analyzing different topics, for instance structural change, change in consumers tastes for meat as well as advertising effects and health concerns. More recently disaggregated products have been the focus since not all meat cuts are the same in the consumer's eyes and the studies are more applicable for the industry. Elasticity estimates can be sensitive to many factors such as (1) chosen functional form (2) type and timeframe of the data (3) any restrictions or assumptions placed on the model.

One of the first demand studies for meat in Canada was done by Hassan and Katz (1975). They examined the structure of meat demand in two time periods 1954-72, 1957-72 using annual time series data. Beef, chicken, lamb, veal, pork, and turkey are all meats that they derive price and income elasticities for. The exogenous prices in the model are because it is assumed that Canadian retail meat price is heavily influenced by US livestock prices. SUR and FIML techniques were used as the estimation method on a double log functional form. The results were as expected, all own price elasticities are negative and all cross price elasticities are positive indicating that the meats are substitutes, but the cross price elasticities are not given since they probably were not significant. The paper noted that estimating income elasticities in time series data can be problematic since per capita disposable income can be correlated with prices and income

tends to go up every year. The model predicts 1973 consumption levels fairly well when the exogenous variables were put into the equations.

Hassan and Johnson (1979) analyzed Canadian meat demand where they comment on the issue of functional form selection and how it should be done on a systematic basis. Using a Box-Cox transformation they estimate a number of functional forms like linear , double-log, semi-log, log-inverse just by changing two of the parameters to values in the interval (-1,1). Maximum likelihood and seasonal dummy variables are used in the estimation of the demand equations, using quarterly time series data; since the values of the likelihood function are maximized at different values for the meats it seems that the appropriate functional form differs between commodities. The calculated elasticities can be up to 100% different from what would have resulted with an arbitrary specification, however all of the functional forms seem to produce own and cross price elasticities that are not drastically different.

As time went on researchers started to find evidence of structural change in meat demand, many destabilizing factors such as energy prices and inflation may have contributed to the change (Braschler, 1983). Chavas (1983) also found evidence of structural change in beef and poultry estimating demand in two time periods 1950-70, 1971-79. He found that the structural change occurred in 1974 and that poultry is more income elastic then beef.

Hassan and Johnson (1983) estimated Canadian consumer meat demand again but this time the focus was on finding an appropriate seasonality hypothesis. Usual assumptions that they are fixed and constant shifts of the intercept may be too restrictive. They tried four different effects (1) no seasonal effect (2) fixed effect (3) random effect

(4) fixed and random effects. Two other more complex models are tried which before this time were not used for the seasonality problem, they are (1) error components (2) SUR. The resulting estimation appeared to be reasonable and consistent with theory in terms of magnitude except for turkey demand. Adding fixed and random effects improves the explanatory power in terms of the $R^2$. Fixed effects models seem to work the best for within sample simulations, but for out-of-sample forecasting performance using GLS, fixed and random effects, error components and SUR are more attractive. In conclusion if seasonality is suspected in the demand for the product then dummy variables with fixed coefficients should be used. However, when seasonality is uncertain then models that include random effects may be superior.

As soon as the hypothesis for structural change in meat demand was proposed authors like (Huidacher 1983, Wohlgenant, 1983) argued against it by stating parametric analysis cannot track structural change, and proposed an indirect approach. Any model having excellent predicting power without structural change then if structural change actually had occurred it would be insignificant. Wohlgenant (1983) suggested that the structural change hypothesis is not as important for economists as it is for other fields of study, instead he suggests focusing on demand model misspecification problems. Moschini and Meilke (1984) studied US beef demand using quarterly 1966-1981 data also found weak evidence for structural change concluding that if it did occur it happened before 1973. They stated the same idea as (Wohlgenant, 1985) that the reason structural change was found by Chaves is because he used a constant elasticity functional form.

The debate over structural change continued for many years between economists finding and not finding evidence for it in roughly equal proportions. Wohlgenant (1986)

used a Rotterdam model to look at US beef demand with annual data 1956-83. The interesting approach of this paper was it separates hamburger from other beef and finds that hamburger is more substitutable with poultry than other beef types because of the fast food industries rapid growth over this period. Although no evidence of structural change was found, he sites health concerns as a factor that may have changed people's tastes but the cross price elasticities with poultry should have had a more uniform patter. Dahalgran (1987) found that any changes in the interaction of beef and chicken started in 1969 and was over by 1980 and hypothesizes that the shifts were probably due to changing supply conditions but meat demands remained stable. Since 1980 meat demands have stabilized but are less elastic then before. Thurman (1987) analyzed US meat demand with a emphasis on poultry using 1955-81 annual time series data estimated with a log-log functional form. He looked at pre-determinedness of price (short run fixed retail price) and quantity (biological lags) in poultry demand models. Evidence for structural change was supported and occurs in 1973. The cross price elasticities with respect to pork fell, and a positive intercept shift occurred around the same time causing increased chicken demand at all price levels. The fast food restaurant like KFC made specialized equipment purchases making them less responsive to changes in the price of substitutes like pork; however household consumers can switch easily between meat types. Tests found that price was predetermined suggesting two industry classes where one industry is competitive with constant returns to scale technology and in the other market class prices are sluggish. Young (1987) studied Canadian meat demand using quarterly 1967-84 data, testing four different functional forms; found structural change but not in beef just pork, poultry and turkey in (1974Q1), (1978Q2), (1978Q1)

respectively. He went on further to give possible reasons for the structural change in meat demand.

(1) **Demographics**: population and immigration trends, more females working and less time for cooking
(2) **Economic**: rising real incomes, but lower proportion spent on food, FAFH expenditure is increases, real price of meat fell but not so much in Canada due to supply management.
(3) **Health Factors**: concern over high cholesterol, high fat, suggesting that red meat consumption may be unhealthy.

Eales and Unnevehr (1988) analyzed the demand for beef and chicken products in the US using 1965-85 data estimating a dynamic AIDS. They suggest that nobody has looked at poultry products specifically even though the different types of products being offered has increased considerably. The objective of this paper was to see if consumers allocate expenditure among meats by animal origin or by product type and to see if disaggregation of meat products in a demand model gives some insight into the causes of structural change. They found that hamburger and whole birds are inferior goods. The separability tests showed that consumers choose among meat products rather than on the basis animal origin. They questioned the usefulness of analyzing aggregate beef and chicken suggesting that a full understanding can only be achieved by studying disaggregated meat products, justifying the approach taken in this thesis. Evidence of structural change exists for chicken and beef parts in the disaggregated model, but in the aggregate model only chicken shows significant structural change. A shift in preferences occurred towards chicken parts and processed chicken, however the demand for whole birds declined. After 1974 a preference shift occurred away from beef and towards chicken implying that consumers allocate expenditure across all meat products at once or between high and low grade products from different animals, other allocation schemes

may bias the results. Along with a decisive shift toward parts a 6.4% growth rate was found for parts and processed chicken and a 3.5% decline in table beef cuts after 1974, but the demand for hamburger was slightly higher. Again they cited possible health concerns causing the shift, but also the demand for convenience food where the chicken industry has responded to the change by making new products something that the beef industry had not done yet.

As the eighties ended and the 90's began more people were accepting structural change in the US meat demand (Moschini and Mielke, 1989; Choi and Sosin, 1990) but the evidence was still not conclusive. Alston & Chalfant (1991) asked the question "Can the con be taken out of meat demand studies?" By "con" they mean the conclusions about structural change are sensitive to the type and time period of the data, the chosen functional form, the testing procedures, and restrictions on the demand system used to verify the results. They tested two single equation models and four demand systems. The apparent dichotomy in the literature about whether structural change occurred or not tends to be a matter of the functional form and testing procedures used. Non-parametric tests were used on Canadian data to test for structural change, they were concerned that parametric tests can be prone to type I errors which is the probability of finding structural change when it never occurred. They used a non-parametric test because the true functional form can never be known, the only hypothesis they want to test is if preferences are stable, without assuming a form. The non-parametric tests still faces a question of statistical power (i.e. can the test detect structural change if it has in fact occurred). It is important to realize that its hard for any test to have high power if the data has only small variation in relative prices but a large growth trend in total expenditure,

such is the case for meat studies. They did not find evidence of structural change, the non-parametric tests indicate the data could have been created by a stable, well behaved system of demand equations. When using the Rotterdam and parametric tests they also found stable preferences which is consistent with their non-parametric tests. However, when they estimated an AIDS model it indicated structural change which goes to show how easy it is to make a type I error with incorrect model specification. In conclusion they say that economists need to be more careful in using fragile inferences to make recommendations.

Reynolds and Goddard (1991) analyzed structural change in Canadian meat demand using a time-varying AIDS. They argue that some previous papers on structural change assumed that it happened suddenly, but tastes and preferences may be gradually changing. If a model does not reflect the change accurately then parameter consistency may be incorrect leading to inappropriate policy actions, for example on the effectiveness of advertising by meat marketing groups. The model used here assumed unknown join points (points in time when the beginning and end of the regime occurred), which allows for the possibility of gradual change. From the ML estimates the hypothesis of no structural change was rejected and it appears that the change began in 1975Q1-1984Q1. They find that most of the own price, cross price and expenditure elasticties have changed after structural change, becoming more elastic. Although declining disposable incomes may have caused some reduction in beef demand, the timing of the structural change estimated by the model would suggest that dietary concerns may have played an important role in structural change as well.

Chalfant, Gray, and White (1991) estimated an AIDS with aggregated Canadian data for the years 1960-88. They used a Bayesian approach to impose inequality restrictions on substitution elasticities, using Monte Carlo integration. The inequality restrictions are constraints of monotonicity and concavity. Flexible forms often suggest the Bayesian approach is superior to other alternatives like searching over different flexible forms or to impose inequality restrictions on ML estimation both of which have drawbacks intuitively or statistically. Prior beliefs that are represented by inequality constraints are easy to handle in the Bayesian approach. Weak separability was assumed for meats from all other goods, the data came from Agriculture Canada, and a trend variable was included after 1975 when it was thought that the structural change occurred. The procedure resulted in support for concavity and monotonicity which are consistent with the model. There is a low probability ($p=0.28$) that all meats are substitutes. They conclude that if one is not concerned with the AIDS and that all meat are not substitutes than the constrained elasticity estimates can be used for policy analysis.

Chen and Veeman (1991) used a dynamic AIDS to study Canadian meat demand using quarterly data 1967-1987. One drawback to the static AIDS is that it does not allow for habit persistence and dynamic consumer behavior. They used parametric tests to study demand stability, it turns out that homogeneity and symmetry were rejected by the static model but the dynamic one does not reject them. Habit persistence seems to be supported by the model, and chicken is more expenditure elastic than beef or pork. Structural change was also supported since expenditure share spent on beef declined 6% and chicken increased 33% since 1976 keeping relative price and total expenditure constant. They sited health concerns, changes in the nature of poultry products, and

growth in the fast food industry as one possible reason for the structural change as well as some change in relative prices and total expenditure.

Moschini and Vissa (1993) model Canadian meat demand using a "mixed" model which is between a direct and inverse demand function, where the quantity dependant is the direct demand system and the price dependant is the inverse demand system. In the mixed demand system some prices may be predetermined and for other goods quantity is predetermined so that prices must adjust to clear the market. This approach has been ignored in empirical studies probability because both the direct and indirect utility functions are needed to characterize demand. They estimated a Rotterdam mixed demand system and apply it to Canada since beef and pork are free markets but chicken is not because quantity is controlled so that price must adjust to clear the market. Some of the problems of flexible functional forms are overcome by the mixed model, and when compared to a direct Rotterdam, the elasticities are similar. However, for chicken the own-price elasticity is larger in the mixed model.

To this point all of the papers have estimated models with time series data but one drawback is that demographic effects cannot be included. Cross sectional survey data offers an opportunity to include demographics in the demand system. Nayga (1995) studied meat product demand in the US using 1992 consumer expenditure survey data. Estimation was done with a QES with a two step estimation process. In the first step a Probit regression was done to construct a binary variable reflecting the decision to consume the product, which overcomes the zero expenditure problem common in survey data. Inverse mills ratios are then calculated for use in the second step estimation of the expenditure relations. The actual estimation was conducted with SUR. No

multicollinarity was found as the number of earners increased expenditure on chicken parts increased but expenditure on whole chicken dropped. The larger the household the less is spent on chicken and poultry expenditure is lower in the first quarter of the year. He found that expenditure on chicken initially decreases with age but then increases as the household gets older, perhaps due to health concerns. Demographic factors are important on expenditure for disaggregated meat products, however the set of significant factors are not the same for each equation even for products that have the same animal origin. He concludes by saying that its important to study meat demand at a disaggregated level to help producer and consumer groups better know the factors effecting demand.

Xu and Veeman (1996) conducted a joint non-nested test on the linearized AIDS and Rotterdam with and without structural change and structural change was included through a gradual transition specification. The point of the joint test was to test for the appropriate functional form and structural specification at the same time using Canadian meat consumption data 1967-1992. They found that the model which includes structural change may be better but it is not conclusive, and the AIDS with a gradual transition specification is better than the Rotterdam with the same specification. Also the effects of functional form on the elasticities are minor in comparison to how structural change provisions affect the estimates.

Eales (1996) commented on the vast array of different demand elasticities calculated over the 1990's. He suggested that dynamics and endogeneity of the RHS variables are important for demand elasticities. He estimated ordinary and inverse differential AIDS models using 1970Q1-1992Q2 data, the model was applied in static

and dynamic form and current quantities and prices are predetermined (constituting the symmetrical approach used to solve the problem of widely different elasticity results in the past). Using a series of non-nested tests, he found that dynamic versions where much better then static versions and endogeneity exists in both types but is worse in the static model. In terms of elasticities the inverse AIDS were fairly elastic compared to the AIDS and they become more inelastic as dynamics were included. One must be careful when including these factors into demand systems.

Survey data was also used in other countries to estimate poultry demand (Dong and Gould, 2000) for Mexico, a double hurdle model and a LES were used. The double hurdle model is developed as demand for a composite food, which endogenizes the commodities unit value. This allows for modeling of non-purchases as well as household and quantity based effects for actual purchasing households. Results showed that demographics are important and as income increases poultry consumption goes up by 47% and quality of purchases also increases reflected by a 9% increase in the unit values. However, as family size increases there is a negative impact on product quality but a positive impact on conditional expenditure, so that the net impact will be determined by the relative strength of the two forces. He concluded that in Mexico relatively minor changes would occur in the quality of products purchased if income went up, this has major implications for processors desiring to develop new higher value-added poultry products. Contrary to trends in North America, in Israel chicken demand has been going down (Heiman, 2001) so the marketing boards wanted to find out what factors besides income affected purchases. They used a Probit regression with a Heckman two step procedure with survey data, looking at chicken, turkey, beef, also processed chicken,

turkey and ready to eat meat. The findings of the study show that people still like to eat what they want and income has a positive effect on level of consumption. However, lifestyle variables were important, if the cook enjoyed cooking purchases of ready to eat meat decreased, therefore providing recipes with meat may increase demand by increasing cooking quality and thereby increasing the family's preference for the meat.

In Canada though, no study has been done on the demand for chicken products and parts, even though chicken is the most popular meat (CFC 2003 Chicken Handbook). By providing an overview of previous demand papers it gives an indication of what still needs to be done and possible new approaches that can be taken in meat demand studies. It illustrates the need for more disaggregation on a particular meat product, in order to come up with consumer's preferences for different products in terms of fresh vs. frozen and perhaps even difference in white and dark meat demand. The previous studies, especially in Canada have not utilized scanner data; a new and highly informative data which can allows study of detailed products. Scanner data studies usually are conducted in shorter time span because of the nature of the data. Therefore, the structural change arguments are not very important for these studies as compared to annual or quarterly aggregate time series data. See Table 2.3 for a summary of previous papers own and cross price elasticties for beef, pork and chicken.

Scanner data provides a rich new source of data available for researchers to study individual meats in a much more detailed way. This is not to say that more aggregate studies are not important, but their application is limited for certain groups, while others like producers, processors and retailers need more disaggregated studies for product development and promotional purposes. The need for more detailed studies allows the

different market agents to increase industry profitability and efficiency. The next section in the literature review conducts an extensive review of scanner data papers from the US and Canada where major papers are discussed in detail and minor ones are summarized in Table 2.4 for easy reference. A summary will follow clearly illustrating the different approach for Canadian meat studies and how the work done in this thesis fits into the overall picture of previous and current work.

**2.7 Scanner Data Paper Review**

As early as 1971 researchers were noticing that aggregate time series data was not sufficient for tracking consumer's response to price changes in the market (Purcell and Raunikar, 1971). A better source of data was needed because aggregate time series data has problems like (1) limited explanatory variables (2) multicollinarity (3) lagged adjustment response (4) averages over long time periods that conceal individual changes. To overcome these limitations panel data was used to study meat demand over a short period of time in Atlanta. Meats like beef, veal, pork, poultry and fish were studied since they are subject to frequent price changes compared to other food commodities, and are highly substitutable if for no other reason but the sake of variety in the diet. Consumers often have a delayed consumption response due to habits and customs and incomplete knowledge about price changes. This paper assumes a week is the relevant planning and action period with respect to food purchasing and pricing policy. Prices at retail stores are generally announced in the newspaper or other media every week. When this paper was written scanners did not exist so panel data which is a combination of time series and cross sectional data was used. Some of the panel data's advantages are that specific consuming units react to price or other changes in the marketplace, avoiding such

problems like simultaneity or predetermined supply. However, the main disadvantage is that only a limited sample representing a small proportion of the population is taken and results may not be transferable to other time periods or locations. Consumers were found to be more resistant to decreasing purchases in response to rising prices than to increasing purchases in response to falling prices for price changes of comparable magnitude. The results seem to support habit persistence in meat consumption.

One of the first demand studies to use scanner data applied to meat was Capps (1989), he studied disaggregated beef, pork, and chicken products at a retail store in Huston. He used a double-log functional form and weekly aggregation on the data, estimation was done by SUR under the assumption of perfect supply elasticity. Own and cross price elasticities as well as advertising elasticities are calculated, also many interesting variables like holiday, seasonal dummy variables and a binary nearness to payday variable are included. A lagged dependant variable for capturing habit formation and the two advertising variables including one for the amount of print space given to a particular meat product and the other for the amount of print space given to competing meat products.

Capps and Lambregts (1991) used scanner data to look at fish demand in a retail firm in Houston. Both fresh finfish and shellfish were analyzed in order to estimate retail demand relationships for the different species. Also price and advertising elasticities show the sensitivity of purchases to advertising effort. This type of data allows analysis of disaggregated products reflecting current market conditions. Finding the daily aggregation too complicated they constructed a weekly aggregation to make the data more manageable and the computations simpler. The demand functions included price

variables as well as non-price attribute variables such as hours open, and advertising. A double-log functional form was used with the assumption of perfectly elastic supply for the local market. To circumvent potential collinearity problems cross price effects correspond to weighted average prices for other finfish and shellfish. Also cross-price effects were of two types (1) cross-cut effects between finfish and shellfish (2) cross product effects (poultry, beef). Cross-cut elasticities correspond to the cross species group elasticity, not different product forms or cuts of a particular species. Many of the cross product advertising elasticities were positive rather than negative. With respect to poultry they found that poultry is a substitute for tuna, and a complement for trout. Advertisement space for poultry influences purchases of crab, whitefish, halibut, etc. Most of the products were elastic, implying that the store could lower prices on selected items and increase revenue. However, it is not discernable whether a strategy to decrease own price was preferable to one that increased exposure. Public policies to increase production may lead to lower prices for consumers and still increase total revenue for the producers (provided the derived demand elasticities remain elastic).

By the early 1990's agricultural economists were starting to realize that scanner data offered a non-traditional source of data where econometric applications could be used. Scanners were first introduced in US supermarkets in 1972, and by 1988 almost 60% of the grocery business was getting scanned (Nayga, 1992). Nayga criticized traditional time series data for being too general and not reflecting true market conditions which are necessary for product specific decision making. Traditional time series data lacks disaggregated products and pricing detail. Panel data is more specific for certain products and includes demographic variables but this is an expensive method of data

collection. A major limitation is the lack of price information and panel data prices must be imputed from reported quantity and expenditure, there is a lack of time continuity in panel data as well. Scanner data is primary with properties similar to both cross sectional and time series. The observations occur over time, usually daily, and across different stores or even regions of the country. Scanner data is a rich source of information that contains expenditure data (price, quantity) over a large amount of products. In the past retailers conducted tabulation experiments for estimating retail demand and promotion effectiveness. The manager's job is much easier with scanner data testing the effectiveness of other in store strategies such as space allocation, display, and pricing adjustments. However, scanner data does not come without some concerns, if the study is specific to a city or store then concerns arise with generalizing the results to a national or even a regional level. The study being conducted in this thesis avoids this problem since the data is on a national level. Other concerns include (1) amount of information (2) lack of demographic and income information (3) the problem that FAFH is not represented. Nayga notes that socio-demographic information is essential for derivation of income elasticties and the actions of competitors are difficult to measure and evaluate and with scanner data. Non-price effects are difficult to represent such as, merchandising schemes, coupons, store selection, cleanliness etc, especially with national data. The growing restaurant industry could also benefit form this type of data, but they may have other systems like computer logged orders which essentially serve the same function as scanner data. Inaccurate scanning by store workers may also lead to some error especially if the codes are not entered by hand and scanner data is costly compared to aggregate time series data. Eastwood (1990) concluded that new analytical approaches to studying

demand are possible with scanner data especially substitute and complement relationships in order to better estimate the trade off consumers make in food selection. The Nayga (1992) paper was the first one that truly recognized the potential of scanner data for agricultural economists. See Table 2.4 for a summery of previous scanner papers which comes form a variety of sources and conduct different experiments on a wide range of retail products.

## 2.8 Review of Supply Management in the Canadian Poultry Industry

The Canadian chicken industry operates under supply management market regulation; any study dealing with the chicken industry has to take this into account since it could affect the results or interpretation of the results of an analysis. Supply management is not unique to the poultry industry, the dairy industry is also managed through this mechanism. Marketing boards feel that their actions are WTO neutral since they are consistent with Canada's international trading rights and obligations, this status could change in the future since the policy involves restricting trade. Many authors have argued the pros and cons of the system for years and conclusions have been mixed, many find the societal cost to be large and some find it small. The theory is that consumer surplus is being transferred to producers and this is resulting in deadweight losses as well as one group benefiting from another. The debate often gets political as different groups lobby government and the public on their position. Besides consumers, retailers and restaurant owners are also greatly affected by supply management since the costs of there inputs are higher the profitability of their operations may go down. How much of the burden they can pass on to consumers depends on the market structure in which the various agents operate. This section reviews many of the supply management papers

written in the last twenty five years to see the results of various types of analysis to measure the benefits and costs of the system.

Jorgenson et al (1980) used a compensating variation (C.V.) approach with a translog model to analyze the effect of changing the policy for decontrolling oil prices in 1979. This study is a good place to start because the C.V. approach was new and as opposed to analyzing the effects of controlling a market the papers looks at the welfare effects of decontrolling, something that may occur in the Canadian poultry industry in the future. The C.V. is defined as the additional expenditure required to achieve the same level of utility as before the policy change if the C.V. >0 then welfare for the consuming unit has gone down. One interesting feature of this paper is they avoid using the theory of the representative consumer by using the theory of exact aggregation.

Schmitz (1983) reviewed past papers in supply management in order to provide suggestions for further research since marketing boards influence so much of farm cash receipts. Most studies have found sizable costs to consumers and gains to producers. For example (Veeman, 1982) found the net effect to be insignificant but it resulted in misallocation of resources since producers gain some degree of market power. Except in dairy the social cost and economic loss in efficiency seem to be insignificant. Conclusions state that more research needs to be done on supply management in a rent seeking and industrial organization framework. Supply management may reduce the uncertainty for risk adverse producers by shifting their supply curve to the right. The assumptions one makes in their research can easily make supply management a PEST = (political economic-seeking transfer) which creates a large transfer and net loss in

economic efficiency or a PERT = (political economic resource transaction) whose purpose is to increase the size of the pie (Rausser, 1992).

Faminow and Benson (1984) were one of the first to take up Schmitz's call for a rent seeking framework. Rent seeking attempts to bridge the gap between economic and political factors as policy formation. Their hypothesis was that when a government places restrictions on economic activity rents arise which are competed for which pulls productive resources to an unproductive use implying that it's a negative sum game. In a supply management system if there is more than one potential monopoly, organizations will compete for those rights until the cost of obtaining a monopoly is exactly equal the expected profit of being the monopolist. Rent avoiding lobbying can also occur that still pulls more resources away from productive use. Rent seeking looses could be greater than deadweight losses, organizations like Safeway or KFC may engage in considerable rent avoidance even though consumers may not. Except for dairy large social costs are not generated but society's losses from supply management are not insignificant.

McCabe (1986) studied the allocation agreement and the paper looks at the objective of supply management as a way to increase farm income and decrease its variability to keep the family farm structure which is thought to be competitive and healthy for the economy. Before supply management farmers had little bargaining power and inelastic demand caused large price fluctuations from small changes in supply. The feather industries had a push effect of rapid technology change and a pull effect of vertical coordination of processing and feed companies in the 60's. Due to allocation agreement comparative advantage in certain regions cannot take hold. Producer prices are more stable in Canada but processor and wholesale prices are more stable in the US.

They argue that supply management slowed vertical coordination. Supply management increases farm income but transfers have been capitalized into higher asset values and new entrants face higher costs and can only benefit if they can extract monopoly profits, and processors are not able to take advantage of economies of scale.

Veeman (1988) analyzed supply management again using partial equilibrium analysis and addressing the issue of inter-provincial trade. Due to the provincial trade wars in chicken the CCMA, (now the Chicken Farmers of Canada), was created in 1978. It did not restrict inter-provincial trade but it made the rule that the price could not be less than the trading price in that province plus transportation cost, this essentially was a provincial self sufficiency policy. Although trade restrictions are justified at a time of war or in an infant industry case or to protect against dumping, inter-provincial restrictions seem unjustified. She estimates the social cost of regional self sufficiency and why it enjoys wide political support. Since consumers interests are diffuse producers lobby because the benefit is greater than the cost. Rural political view is homogeneous increasing the marginal value of the rural vote so producers actively engage in rent seeking. There is real cost to the provincial trade restrictions but they are probability less then the cost of administering the program.

Moschini (1988) estimated a model of supply management with an output constrained multi-product profit function using a quadratic functional form. The objective of the article is two fold (a) develop a theoretical framework to analyze the resource allocation effects of S.M. policies and (b) asses effects of S.M. on the production structure of the agriculture sector with emphasis on the impact of supply constraints on output supplied and input demanded for both restricted and unrestricted markets.

Unrestricted markets include crops and red meat and restricted markets include poultry and dairy for Ontario. He found that given jointness, the supply of unrestricted output and for variable inputs are affected by the level of regulated output. The affect of S.M. depends crucially on the type of jointness and in production at the aggregate level it cannot be rejected. All outputs are substitutes in production, which provides support for the allocability of fixed inputs which means a decrease in regulated output increases unrestricted output but this substitution is limited since the reduction in regulated output in general lowers the level of input use.

Van Kooten (1990) conducted a cost/benefit analysis on S.M. using consumer surplus, equivalent variation, and compensating variation. This paper illustrated a rule of thumb method for calculating benefits where C.V. and E.V. are true measures of welfare change and consumer surplus is a good approximation if only one price change occurs. Impacts are felt through the cross price elasticities of demand as consumers shift expenditure to other goods. There is some indirect benefit in restricting supply because societies marginal valuation of S.M. is greater than its associated marginal cost, marginal social benefit> marginal social cost more of the good should be produced. The social welfare cost is 7.6mill for the chicken board but if we include indirect benefits of consumers shifting to other food commodities that's worth 2.6mill so the total social cost is only 5mill.

With the signing of the GATT all non-tariff barriers had to be turned into tariffs. In order to keep the domestic poultry market stable a TRQ system was proposed where a certain level of import could occur at a low tariff but any volumes beyond a certain amount would be subject to a highly restrictive rate. Moschini and Meilke (1991)

analyzed the effects of tariffication on supply management on the Canadian chicken market. The question is how high should the tariffs be? The analysis is carried out at the wholesale level. Tarrification is good because it increases the transmission of price signals and corrects the inefficiency due to quantity restrictions. It is possible to raise the tariff high enough to sustain the high domestic price, but that will not maximize consumer surplus. If the levels of imports are retained then the domestic price will fall. They found that 43% tariff is required to keep domestic price constant and 15.4% to keep the level of imports the same the conclusion is that by moving to a variable rate tariff the domestic price could be sustained along with an adequate amount of imports.

Babula and Romain (1991) argued that supply management is being used as a shield from US price volatility. Using a Vector Autoregression (VAR) technique they test two models one before S.M. and one after analyzing the effect of a one time increase the US farm price. They found that US price movements are smaller and less enduring now than before supply management. The Canadian farm and retail price responses appear to have been eliminated, the forecast variance decompositions imply that the recent Candian retail price is more exogenous and less dependant on the Canadian farm price than before. S.M has been successful at blocking price transmissions and reducing market volatility.

Schmitz and Schmitz (1994) studied the costs and benefits of supply management and major aspects like rent seeking, import quotas, cost of production pricing, quota value and inter-provincial trade. S.M. is criticized by many as inefficient, slowing new product development and that consumers pay too much. The system is analyzed in a rent seeking framework to discover the forces that could collapse it. Rent seeking lowers

production, increases inefficiency, and decreases aggregate welfare. Their results indicate that the net effect is negative but small and insignificant in the short run. Positives of the system include protection against a US style market structure where 3-4 firms control 50% of the benefits. In Canada there is retail market power implying an increased price of consumer products may not be entirely due to S.M.

Beck et al (1994) used an amortization model and try to estimate the social losses from S.M. The model incorporates market value of quota using a discount rate which includes a risk premium reflecting possible dispersion dates compared to if the quota life was certain. They found that the cost of S.M. is 500mill in lost consumer surplus and a 100mill in annual social welfare loss. Since farmers do not anticipate quota investment as a life perpetuity there is a risk premium built into the quota which amplifies the losses. Recommendations included making quota short term and auctionable removing the criticism that farmers are enriching themselves. This proposed change would cut social welfare losses in ½ from its current value, and when the quota expires there is another opportunity to move towards a free market.

Larue (1994) studied the dairy sector with the objective of discussing short run and long run implications of GATT and NAFTA agreements on the workings of supply management where concerns of market access are overridden by pressures to maintain a high domestic price. The system has allowed producers to exploit the slope of the demand curve. If producers were optimizing they would set production quota to achieve the monopoly price. The amount of rent embodied in the difference between MC and the domestic price has been capitalized in the value of production quota. Processors can not take advantage of economies of scale resulting in x-inefficiencies due to lack of

competition. Tariffs would be a better mechanism under free trade because it would generate smaller deadweight losses in contrast to production quota's. Many of these arguments made about the dairy industry are directly transferable to the poultry sector as well.

Schmitz (1995) studied S.M. in a rent seeking framework offering Stigler's theory as a hypothesis as to what might have happened in the domestic industry. According to Stigler's theory of regulation, whenever a regulation is put in place the regulators over time get captured by the regulated which results in excess profits for the industry. Originally supply management was created to deal with chronically low and unstable prices and middleman gouging, many years later the producers are now monopoly pricing. Task forces created for S.M. often favors producers which have the same political ideology, making the cartel extremely hard to break. Many groups join together and speak with one voice when it comes to S.M. because the return from $1 rent seeking by government lobbying has shown to have considerable returns; this is why it survives so long.

Norman (1998) studied supply management and market power together. If supply management were to stop most would believe that perfect competition would fill its place but no allowance is made for the possibility of market power which may lead to overestimation on the welfare impacts of supply management. Monopoly power by producers through marketing agencies and monopsony power by processors may be counteracting each other. Not implying that the market is perfectly competitive because one party may have more power than the other and the residual could still be significant. In order for market power to be successful the product (birds) must be homogeneous. The

basic results show that if processors have an oligopsony/oligopoly situation then their market power increases, contingent variation elasticity increases and consumer surplus decreases. However, with supply management the consumer surplus loss is not as great provided $\theta$>0.37, and producer surplus is always more with supply management than without.

Gervais and Suprenant (2003) analyzed the allocation of TRQ's within the supply management system. Currently they are allocated on historical criteria and they propose that allocation on a first come first served (FCFS) basis could be better. Assuming that the retail sector is competitive and that any existing market power is held and the processor and producer level. Under the FCFS scenario the TRQ could be filled in the first period or some filled in the second period. Results indicate that under a FCFS system there would be a race to the border effect where all import licenses would be filled in the first period because importers would want to capture the rents. Under a constant farm price it would appear that FCFS is welfare improving but any trade liberalization would hurt producers.

Supply management continues to be an important topic and no poultry study can ignore its ramifications. Supply management is closely related to market a power issue which is the next sections topic.

## 2.9 Market Power in the Canadian Poultry Industry

In order to calculate an optimal pricing strategy for the chicken industry in Canada it is important to look at the market structure and any market power that might exist. This next section reviews papers that analyze market power in a variety of markets but the meat packing industry in Canada and the US are given special focus. Market

power exists when a firm or a group of firms can artificially raise the price of its output above marginal cost or bid for its inputs below their marginal value. If it is one firm then it is a monopoly/monopsony if its a small group of firms operating collusively then its known as a oligopoly/oligoposony.

A common approach for analyzing market power is the conjectural variations elasticity approach combined with the Lerner index to test the degree of market power and then to test how far away the market is from perfect competition. Applebaum (1982) applied this approach to four different industries in the US, specifically tobacco, electrical equipment, rubber, and textile. In order to conduct the analysis he estimated input demand functions using full information maximum likelihood FIML. The hypothesis was that textile and rubber should be competitive but machinery and tobacco should not, and a Herfindahl index is needed to measure the degree of concentration. Applying a stochastic Cournot model of firm behavior the conjectural variations elasticity was found to be significant for the tobacco and machinery implying they have some market power.

Lopez (1984) used the conjectural elasticities model to study the Canadian food processing industry and estimates a model of food price determination using industry input demand and food demand without imposing perfect competition on an a priori basis. Conjectural elasticities are calculated to test competitive behavior and the degree of market power. The results indicate that the higher the degree of concentration, the higher level of collusion is combined with an upward tend in the degree of concentration. Factor demands show an inelastic pattern, labour appears to be the most responsive input. Due to concentration ability of firms to communicate increases the mark-up to about 1.18% per year.

Azzam and Pagoulatos (1990) applied a conjectural elasticity model with a translog production function in the US red meat packing industry. Using a production function approach to extend market power studies to the case where the firm in question is both an oligopsonist buyer and an oiligopolist seller. The inputs they use tend to be localized with very few outlets for farmers to sell their stock. Results indicate there is market power in both the input and output market and the degree of non-competitiveness are about the same, the lower the price elasticity of supply the higher the oligopoly power. The degree of market power in the input market is much higher than the output market implying that the industry is a collusive oligopsony.

Cranfield and Goddard (1996) determined the degree of oligopoly power and the impact of increased beef advertising using a C.V.E model with a Lerner index and a cost: benefit analysis. Results indicated that there is significant market power in the industry but that it is not too strong L.I. = 0.125. The direct effect of brand advertising is to lower the conjectural elasticity while the generic advertising increases it. They simulate increasing generic advertising by 20%, and alternatively put that money into US generic advertising. Generic advertising was found to increase oligopoly power in both simulations. The cost/benefit ratio is -0.202:1 in Canada and 0.9586:1 in the US implying that the beef industry should consider advertising more in the US. In Canada it increased the Lerner index much more than it did in the US, so where the money is spent can affect the degree of oligopoly power.

Fulton and Tang (1999) analyzed the market structure and market power in the Canadian chicken industry using an equilibrium displacement model. The estimation equations are reduced form retail, processing, farm price, and price ratio equations, pre

and post supply management time periods are studied. They hypothesized that the market power is coming from the processors and retailers. Find that the departure from perfect competition in the retail and processing sectors is significant in the study period, but they could not tell where the market power lies implying that higher Canadian prices for chicken may not totally be because of reduction in supply at the farm level. Weak results point to the fact that supply management may have increased market power. When studying this industry it must be studied as a system not as a series of independent sectors.

Parcell and Pierce (2000) estimated an inverse demand model for US turkey and chicken industry to gain understanding of the factors that cause fluctuations in the wholesale poultry price so that processors, retailers and producers can manage price risk. Wholesale prices are at the center of this market and are determined by the derived demand of the retail poultry cuts and demand and supply of broilers. The lagged dependant variable was statistically significant for all poultry cuts so that long-run shocks to independent variables will be twice the reported magnitude to as high as 12x the reported magnitude. The short run own-cut flexibilities were statistically significant and negative indicating that a 1% increase in per capita consumption of beef and pork generally has a positive impact on wholesale prices. Increased marketing costs increased whole prices on turkey cuts but not on broiler cut prices. Wholesale prices exhibited a seasonal trend. Studies reveled that consumers demand for poultry varies by cut as well and own-cut and cross-cut flexibilities were unique to individual cuts.

Sexton and Zhang (2001) reviewed the US food industry and issues of market power using a linear functional form. They found some problems with the conjectural

variations framework including that with the Cournot equilibrium since market power tends to be small, and secondly the architects fail in many cases to think about the relevant market in which the firm operates. They conduct simulation analysis calculate CS, PS and social benefit. The paper focuses on possible consumer impacts of concentration and market power in the food chain. Results show that even modest levels of market power, when exercised at multiple stages in the marketing channel can interact to cause dramatic shifts in distribution of welfare among farmers, marketers and consumers. Marketers who receive no surplus under perfect competition, given constant returns to scale technology, were able to capture half or more of the market surplus in many of the market power scenarios. Deadweight losses may be small for moderate levels of market power but the effects on distribution can be large.

Paul (2003) estimated a restricted cost function to generate variable input demand equations for labor (L), energy (E), materials (M), output (Y), and an Euler equation for capital (K) for the US meat packing industry. The system of input demand equations is estimated with Generalized Method of Moments (GMM) technique to avoid endogentity, and measure market power though a marginal price ratio. Results indicate significant market power is primary associated with the output market. Significant scale economies are evident which in some sense counteracts the market power. Failing markets many not be causing increases size of establishments but firms taking advantage of cost economies could be the actual reason, especially economies of scale arising from technological factors and equipment. The factors imply that the Lerner Index may be misleading. Little potential exists for further consolidation and policy should be careful not to force downsizing if the consolidation has been due to cost economics.

Barkema and Novack (2001) also analyzed market power in the US meat system in general. They said that there was no evidence the market power held by the industry is hurting producer or consumers but it still needs to be watched closely. Two reasons for the consolidation are consumers demand for safe cheap convenient food and the other is economies of size. Retailers are worried about Wal-Mart's climb to the number one food retailer in 2002 because it forces others to cut distribution costs and consolidation is one way of doing that. Larger meat packers are 25-30% less costly to operate then small plants excluding procurement costs. Poultry is the leader in giving consumers convenient and nutritious food with a "concept to consumer" approach. Farms are also getting bigger because they can spread the average cost of production allowing then more staying power when profits get thin. Practically 100% of poultry is produced in supply chains in the US with fewer firms they can better exercise market power but economies of size is making the food system more efficient. If the anti-trust laws are better enforced it will help producers compete in the food system. However, they point out the classic problem with antitrust is market definition, geography may be important to producers who want greater market access. In the US two options seem to be open to producers, get big or make strong ties with processors and retailers or find a niche market. With larger farms social and environmental impacts of a larger meat industry have to be taken into consideration and if there is an economic payoff for the meat industry locating in a particular community.

Carstensen (2002) looked at market power and its misuse in the US beef industry with respect to their buying practices. The existence of concentrated markets creates the incentive and the capacity for firms to engage in exploiting other participants with fewer

options and entrenching existing market power against the threat of deconstruction and freer competition. The purpose of this paper was to see if meat packers are abusing their power and if so how to make the markets more competitive again. He says strong evidence of abuse exists, but the harder question is how to correct the market. Antitrust laws seem to do a better job of protecting against selling power, but buying power can be more dangerous. He sites large firms like Tyson's increasing vertical coordination by entering into special relationships with retailers to "slot" the products, in other words giving their products special treatment. In the long term he sees the end of the cash market coming and more long term contracts will be made. The beef packers do not want to compete on price at all on cattle auctions by using tactics like "right of first refusal" and only bidding at $1 per hundred weight increase the price of a pen of cattle quickly. He stated that current antitrust enforcement laws seem to be lax because of the recent mergers that they have allowed and he is skeptical that antitrust authorities will even investigate let alone challenge the meat industry on its buying practices.

The conclusions that can be drawn about market power are that it exists in both Canada and the US in all sectors of the meat packing industry. Market power by itself is not dangerous only if the firms use their power to take advantage of another agent in the economy. There are situations where the market can be competitive even with the agents holding market power; in some cases consolidation can make the market more efficient. Supply management may be helping to correct the market power of the processors and retailer or it may have contributed to it.

## 2.10 Strategies In New Product Development and the Problem With Dark Meat

The Canadian demand for chicken has been increasing and the market structure is becoming more integrated. Kapombe and Colyer (1998) found no significant seasonal effect on broiler supply indicating the industry is becoming less dependant on seasonal factors in demand as chicken becomes a staple food in the diet. Part of the reason for this phenomenon is the rapid product development in the chicken industry at the retail and processor level. The consumer can now pick from a wide variety of further processed products not just whole frozen chickens. Private label usage is really strong in the market; stores use this to improve their competitive positioning relative to their horizontal competitors and food processors (Hughes, 1997). Private label foods are not as predominant in the US as it is in the UK or Canada probably because processors in the US hold the market power but in Canada the retailers hold more. The private label invasion has implications for new product development, scanner data gives retailers the power to identify food categories holding potential for private label development. In the past private label food were generic products designed to compete on price but that changed in the mid 80's when goods began to compete on both price and quality. Retailers develop products in high margin area like chilled and prepared convenience food, an area that chicken is well suited. In the US private label product rarely carries the stores name and some retailers will even use the same generic products. In the UK new product ideas seem to be developed in two ways (1) retailers use excess capacity of lower brand name producers which often leads to a copy cat product (2) a more interactive supply relationship where retailers proactively select appropriate suppliers for more premium private label products. Stores will often invest heavily in R&D to come up with

new products but in the US this stalled because of the leveraged buyouts that many for the retail firms engaged in during the 90's. Some US firms even pick up private label products form Canada like the "PC" brand which is known for its sale of up-market innovative private label products. In the UK retailers hire food technologists to work closely with manufactures to ensure high quality since it is the stores legal responsibility and stores image on the line for any failures. The important point to note is that the development of most new private label products is very much retailer co-coordinated.

When stores have their own private labels they can engage in competitive interactions as pointed out by a paper written by (Putsis, 1999). He looked at the games that retailers play between private and branded products. The objective is to describe the methodologies available for the empirical estimation of competition and summaries recent developments assessing the types of complex interactions that exist. Market leaders have been found to lower price and change promotion strategies in response to private label products. The conjectural variations approach is often used that treats firm conduct as a continuous parameter but a different approach is to estimate conjectural variations as a "conduct" parameter which measures the deviation from Nash behavior. The advantage of the latter approach is it does not assume any type of market interaction but lets the data describe the interaction. It is often thought that private labels follow national brands but he allows the possibility that the private label leads. He finds that in most cases national brands are the leader except in milk, frozen vegetables, and fresh bread. Individual firms pricing power depends not only upon demand responses, but on competitor's responses as well. Employing a nonlinear flexible functional form provided substantial information on vertical strategic behavior since it allows for flexible strategic

vertical conduct. The pass through rate under linear demand is always less than 100% regardless of the type of retail competition. The requirement that less than 100% of wholesale price changes are passed on to consumers seems to be in contradiction with what is often seen in reality and may be too restrictive of an assumption. One clear implication is that mangers need to take into account the direction and magnitude of a competitor's response in evaluating a change in the marketing mix. If aggregation bias is not present and aggregate industry level analysis of price-cost margins were able to produce accurate measures of market power and conduct, attributing the source of market power is largely impossible. The more disaggregated the study the better for managerial relevance.

Another issue in Canada is the demand difference between the white and dark meats of the bird. The white meat is in high demand and is used domestically for many fresh chicken products but also for many further processed chicken products. The restaurant industry particularly has a preference for white meat and they are increasing their market share in terms of what types of chicken consumers buy, for example McDonalds changed their popular chicken McNugget to all white meat in 2003 and many restaurants have increased the number and types of chicken sandwiches and wraps that they offer. Much of the domestic production is geared toward the restaurant industry which prefers lighter weight birds. The heavier birds are left for the retail market along with most of the dark meat from all the types of slaughtered chicken. The problem is that there is so much dark meat that exports are needed to move the product from the domestic market. This is a good strategy considering that the dark meat and inexpensive cuts are sold at a premium in many of Canada popular export markets like China (Wang

et al, 1998). As long as per capita incomes continue to rise in China and in other countries the demand should remain strong. One potential problem on the horizon is Canada's export policy given that we regulate our industry. Other counties around the world could claim that Canada is dumping the dark meat on the world market, because Canada would not produce as much chicken as it does without supply management. The processors and retailers have tried to come up with new product ideas for dark meat including items like boneless-skinless thighs and drumsticks, but products like legs and backs are hard to market. Canadian exports have risen considerably since 1992 and the growing demand for chicken in the world market has allowed for easy disposal of the dark meat. The new export policy which came into effect in March 1997 essentially allows the domestic market to produce and source more white meat (USDA, 2003). The demand for white meat is so high that Canada still needs to import it and almost all the imports are white meat parts. All imports come from the US even though Canada does recognize the poultry meat inspection system in Brazil (UDSA Gain Report, 2003). After Russia Canada is the United States largest export market the WTO's position on the supply management five group is unclear now but it is unlikely the US would bring a case against Canada for poultry because their meat processing companies get the internal domestic price which is substantially higher than it is in the US and the amount of imports keep growing every year. Canada's trading rights may change in the future and it is important to know some of the issues that could be challenging the industry.

### 2.11 Summary

The demand for chicken in Canada is complex and many factors need to be taken into consideration to conduct a through analysis. Scanner data has been applied to many

different problems and has proven itself a useful resource for marketing analysis. The data is national retail data that includes price, quantity, and value of many types of individual fresh, frozen, and further processed chicken products. Scanner data will be used to discover complex substitution relationships that exist between different disaggregated chicken products, using TSP version 4.5. Supply management and market power are two factors that effect demand. Supply management restricts the quantity of chicken that is sold in Canada, so the consumer price should be higher than if the market was not restricted. Market power when concentrated in the hands of a few processors or retailers may also lead to higher prices for the consumer. An AIDS model will be estimated and the results should be of use for the industry and policy makers especially the CFC and the provincial boards which can use the results for price negotiations. Retailers can also use the results to better market chicken in their stores since they will have a better idea of the demand profile for chicken allowing them to optimize promotional efforts.

Table 2.3 Own and Cross Price Elasticities for Different Aggregate Meats In Previous Canadian Meat Demand Studies.

| *Hassan & Katz (1975)* | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
|---|---|---|---|---|
| **Beef** | -0.767 | 0.183 | Ng | 0.553 |
| **Pork** | 0.598 | -0.955 | 0.0933 | 0.257 |
| **Chicken** | Ng | 0.1011 | -0.5637 | 0.730 |
| Hassan & Johnson (1979) | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
| **Beef** | -0.453 | Ng | Ng | 0.355 |
| **Pork** | Ng | -0.836 | Ng | 0.437 |
| **Chicken** | Ng | Ng | -0.731 | 0.622 |
| *Reynolds & Goddard (1991) before structural Δ* | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
| **Beef** | -1.0482 | -0.1020 | -0.1150 | 1.2652 |
| **Pork** | 0.1176 | -0.8088 | -0.0673 | 0.7585 |
| **Chicken** | -0.1406 | -0.0948 | -0.1139 | 0.3493 |
| *Reynolds & Goddard (1991) after structural Δ* | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
| **Beef** | -0.7359 | -0.2646 | -0.1356 | 1.1361 |
| **Pork** | -0.3860 | -0.6756 | 0.0774 | 1.1391 |
| **Chicken** | 0.0055 | 0.1459 | -0.3342 | 0.1829 |
| *Chalfant et al (1991)* | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
| **Beef** | -0.403 | 0.230 | 0.158 | Ng |
| **Pork** | 0.325 | -0.591 | 0.235 | Ng |
| **Chicken** | 0.277 | 0.291 | -0.769 | Ng |
| *Chen & Veeman (1991)* | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
| **Beef** | -0.77 | 0.12 | 0.21 | 0.93 |
| **Pork** | 0.19 | -0.82 | -0.08 | 1.01 |
| **Chicken** | 0.02 | 0.08 | -0.95 | 1.04 |
| *Moschini & Vissa (1993)* | $P_{beef}$ | $P_{pork}$ | $P_{chicken}$ | **Income** |
| **Beef** | -0.885 | -0.191 | 0.002 | 1.075 |
| **Pork** | -0.264 | -0.641 | -0.115 | 1.021 |
| **Chicken** | 0.156 | -0.119 | -0.804 | 0.766 |

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| --- | --- | --- | --- | --- |
| *Xu & Veeman (1996)* | **$P_{beef}$** | **$P_{pork}$** | **$P_{chicken}$** | **Income** |
| **Beef** | -0.797 | -0.221 | -0.191 | 1.209 |
| **Pork** | -0.358 | -0.694 | -0.110 | 1.161 |
| **Chicken** | 0.009 | 0.101 | -0.412 | 0.301 |
| *Eales (1996)* | **$P_{beef}$** | **$P_{pork}$** | **$P_{chicken}$** | **Income** |
| **Beef** | -0.81 | Ng | Ng | 0.98 |
| **Pork** | Ng | -0.86 | Ng | 1.27 |
| **Chicken** | Ng | Ng | -0.45 | 0.43 |

Table 2.4 Summary of Previous Scanner Data Papers

| Author | Yr | F(x) Form | Objective | Major Findings |
|---|---|---|---|---|
| Capps | 1989 | Double-Log | Conduct empirical demand analysis for specific meat products, e.g. beef (steak, ground, roast), chicken and pork (chops, ham, loin). | Own price elasticities are significant and negative and except for roast àlso in an inelastic range. Cross price elasticities where positive and significant. Seasonality is evident but the nearness to payday variable was not significant. Own advertising significant except for pork. |
| Allenby | 1989 | Random Utility | Estimate cross-elasticities on different brands of bathroom tissue for a store in Chicago. Identify and test the demand structure to help stores to market more effectively. | Found that within a submarket, market share is the only factor differentiating competitive effects. Differences in market share drives competition not any particular attribute of the product. Found that differences in price and packaging may be successful differentiation technique. Overlapping submarkets yield a better representation of the true market structure. |
| Kumar & Heath | 1990 | Linear Multiplicative Attraction Model | Tested different market share models for disposable diapers and toilet paper, using OLS, GLS using constrained and unconstrained parameterizations. | Econometric models perform better than naive models. GLS is superior for attraction models when fully specified. OLS superior for linear models with important omitted variables. Attraction models performed best overall. |
| Capps & Lambregts | 1991 | Double-Log & Linear | Estimated the demand for finfish and shellfish for a retail firm in Houston. Estimate price and advertising elasticities, includes seasonal and socio-demographic factors. | Estimate both cross price and cross product elasticities. Poultry and beef complements to shrimp and lobster. Poultry a substitute for tuna and a complement for trout. Demand was elastic, therefore their exists an incentive to lower price on certain items to increase revenue, or alternatively to increase advertising. Policy's that increase production may decrease consumer price and increase total revenue. |
| Allenby & | 1991 | Nested Logit | Examine aggregation properties | They find that fitting of aggregate Logit models of |

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| Rossi | | Model | of Logit models to understand their excellent macro-level performance. Eight stick margarine brands were used to create a pattern of price in the simulated experiments on different national private brands. | their linear approximations is justified provided (1) all consumers are exposed to the same marketing variables (2) all brands are close substitutes (3) no extreme concentration of prices exist. |
| Krishnamarthi & Raj | 1991 | Logit Model | Paper looks at brand loyalty segmentation and sensitivity of price in different loyalty segments in ground coffee. | Using panel data and scanner data they find that brand loyalists are less sensitive than non-loyalists in the choice decision but more price sensitive in the quantity decision. Higher non-loyal choice elasticities means that price and promotional activity designed to get consumers to switch brands will work. |
| Fader et al | 1992 | Multinomial Logit Model | This paper introduces a computationally efficient, iterative procedure allowing non-linear parameters to be estimated using standard linear parameter software. An application to fresh orange juice. | A common example where this is used is the smoothing constant in a weighted brand loyalty variable. They prove that the algorithm generates ML estimates for non-linear parameters. They also apply an algorithm to determine a forgetting constant for an advertising response. They advocate researchers program their own likelihood functions using full information ML, with programs like GAUSS or MATLAB. |
| Simonson & Winer | 1992 | Linear Regression | Hypothesis is that as the number of items purchased in a category on a shopping occasion increase, a consumer is more likely to select product variants that he/she does not usually purchase. Experiments or conducted on yogurt. | Yogurt was selected because it's a product category with high variability in the number of items purchased per shopping occasion, and a lot of variety seeking occurs. As the number of items purchased increases consumers pick "new" flavors. When buying more the trend is to stick to familiar brands thereby reducing risk. Identified display format of yogurt as a factor, results suggest that because they are organized by brand it is hard for consumer to search for a particular |

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|---|---|---|---|---|
| | | | | flavor in different brands. Tendency for variety over multiple purchases is the same regardless for the display format. |
| Mayhew & Winer | 1992 | Multinomial Logit | Yogurt data is used to examine whether both internal and external reference prices affect purchase decisions. Internal= actual, fair, sale price External= regular price, where both can be displayed together. | Both types are found to be significant in probability of purchase. One reason could be the fact that external reference prices only contains information specific to the store, while internal reference prices include price comparisons between stores. Suggests that price-cut signals may be more important than the actual depth or magnitude of the price cut. |
| Abraham & Lodish | 1993 | Linear Regression | Various decision support systems can be made using scanner data, for evaluating promotions and improving their effectiveness on a short term basis for more "response" reporting. | An application to toothpaste was conducted for evaluating "brand health". Can also find marketing opportunity matrix to see how the level of promotional support and response interact. Conduct experiments with price changes to maximize promotion strategies in the short and long term. |
| Nayga & Capps | 1994 | Rotterdam also test weak separability | Uses scanner data to test separability among various meat products and sub-products. Separability requires that MRS between commodities is functionally independent of certain other commodities. | If weak separability restrictions are inconsistent with the true preference ordering demand parameters will be invalid. They use utility trees to allow consumers choice between disaggregated product combinations. Used LR test for testing separability restrictions. Weak separability is rejected at the 1% level for all utility trees implying firms must consider the demand for all different meat products simultaneously. |
| Hill & Cartwright | 1994 | Price Promotion Model | They compare the "Equity" estimator to two empirical Bayes estimators and the LS estimator. | The "Equity" estimator first proposed by Krishnamurthi & Rangaswamy is consistent. They find using Monte Carlo experiments based on price-promotion model that the Bayes estimator has smaller MSE on canned tuna data from ACNielsen. |
| Krishnamurthi | 1994 | N/A | They reply to the (H&C) article. | They criticize the (Hill and Cartwright) findings by |

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| & Rangaswamy | | | | saying that they did not use proper data. By conducting a more comprehensive evaluation, they find that the Equity estimator is superior to the Stein estimator which (Hill and Cartwright) propose as better over a wide region of the parameter space. |
| Mulhern & Caprara | 1994 | Box-Jenkins Model | Marketing researchers often want to analyze time series and causal relationships simultaneously. Time series can exhibit chaotic behavior so they introduce a nearest neighbor technique to model using non-stationary complex data. A deterministic approach. | Apply this model to weekly brand sales for consumer packaged goods in a retail store. The model successfully picks up chaotic time series patterns along with other types of behavior. The model can be used to maximize profit by marketing managers in forecasting sales on a real time basis. |
| Abe | 1995 | Non-Parametric density estimation (NDE) | Using (NDE) a kernel method they model consumer brand choice. Very few assumptions are held to minimize the bias. Study powdered drinks such as Kool-Aid. | The (NDE) model preformed better than parametric ML, in terms of model fit and promotion response. Promotion response as predicted by the NDE model suggests that ML models could incorporate specific promotional coefficients and their interaction terms. The Logit model, when this was done produced much more accurate predictions and improved share tracking. |
| Erdem & Keane | 1996 | Bayesian Dynamic Model | Models uncertainty about brand attributes, including factors like usage experience and also advertising exposure. Estimate a dynamic utility maximization and a "forward looking" model where consumers maximize expected PV of utility over a planning horizon. An application | Find that functional forms for experience and advertising effects fit the data well. In terms of consumer learning of product attributes the forward looking model fit well. Consumers are risk averse to variation in brand attributes, discouraging them form buying unfamiliar brands. Scenario evaluations show that advertising intensity has only a weak short run effect. A key benefit of the structural approach used here is also good for policy evaluations. |

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| | | | to Laundry detergent. | |
| Mountgomery | 1997 | Bayesian Model | Estimates a Bayes model to show that prices can be customized for an individual store even though many stores are going national in scope due to economies of scale (micro-marketing). Analyze fresh orange juice. | A challenge for retailers is to keep a constant image while altering prices that adapt to localized demand differences. Search for price changes that keep image constant. Results indicate micro-marketing strategies are profitable and could increases gross profit margins by 4-10%. Gains come from encouraging consumers by way of everyday price changes to switch to more profitable product bundles. Information in scanner data is an underutilized resource. |
| Keane | 1997 | Choice Model. | Studying ketchup data he finds evidence of heterogeneity and state dependence to see if they are important factors for persistence of consumers brand choice | Distinguishing between the two is fundamental in marketing. If there is heterogeneity and no state dependence, a price promotion will increase sales only while it is in effect. If state dependence is there then some consumers will stay with the brand implying it has a huge effect on the cost/benefit analysis with promotion. Evidence of state dependence is found even after controlling for heterogeneity. Implying long term effect of promotion induced purchases on future consumption is probably positive but small. |
| Thompson & Wilson | 1999 | Linear Demand System | Studies the demand for bagged salad. Argues that consistent quality can be bought throughout the year but there is still seasonality in purchases due to the weather. | Summer was found to have more bagged salad sales. Some substitution effect with fresh lettuce was found. Retailers want to know the potential for complementary relationships with other fresh produce to increase sales. Inclusion of a temperature variable is better than seasonal dummy's because it's a continuous variable that saves on degrees of freedom, and reflects inter-year variability as well. |
| Wessells & Wallstrom | 1999 | Linear | Studies the canned salmon industry and tests demand | The elasticities have changed and become more inelastic due to increased supplies and the increase in |

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| | | | structure. Determine the price elasticity for canned salmon, over different regional cross sections to see if lowering the price will lead to an increase in total revenue. | consumer surplus occurred due to a policy shift for salmon enhancement. Markets became saturated and price and total revenue fell. Examining if opportunities exist to increase revenue by lowering price in selected markets. Find that further price reductions will decrease revenue in some but not all cities. Industry will not be able to increase revenue by lowering price implying that R&D into new concepts or increasing generic advertising is a better strategy but who will pay becomes the next issue. |
| Cotterill & Franklin | 1999 | N/A | Estimated the consumer benefit from a 1995-96 campaign to lower cereal prices. | They find that breakfast cereal prices did drop due to the campaign by varying amounts. Private label prices did not drop much but branded products fell 12-18%. Brand advertising was reduced along with the price cuts. Find that Quaker was able to increase its market share while its competitors fell because it adopted a "bagged" format. Consumers estimated savings from the campaign was 2.633 billion dollars 35 months after. |
| Bucklin & Gupta | 1999 | Survey Results | Conducted in person surveys of 41 executives from packaged goods companies, data suppliers, and consulting firms on what questions practitioners would like answered with scanner data and its successes so far. | Practitioners reported scanner data analysis had been successfully applied for decision making in consumer promotions, trade promotions, and price elasticities. Most of these areas seem to be solved. In product strategy, advertising, and distribution management scanner data has had less success. Controversies over methods and what level of aggregation is appropriate is common. Issues of product strategy's, advertising, and distribution are mainly unresolved. Topics of immediate priority include price thresholds, and gaps, baseline and incremental sales, base price elasticity, rationalization of product assortment, and category |

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| | | | | management. Long term priorities should be profitability and prescriptive modeling. |
| Putsis & Cotterill | 1999 | LA/AIDS | Analyze the interaction between national and private brands. A simultaneous system of demand (share) equations is estimated incorporating local geographical market structure. Estimate on 135 food products in 53 markets on the national and private brands | The results show concentration at retail and processing level affect price between the two brand types. Increased retail concentration is associated with increased national and increased private label prices, where increased manufactures concentration is associated with increased national but decreased private label prices. National brand advertising increases price and share but lowers private label price and share. Advertising at the local level plays a role in allowing national brand price premiums. Display activity and private label distribution have an important impact on total category expenditure. |
| Foekens et al | 1999 | Dynamic Scan*Pro Model | The objective is to execute dynamic effects of sales promotion. | By using a dynamic sales model and relating store intercepts and a brand own price elasticity to a measure of cumulative previous price discounts for that and other brands. The brands own non-price promotional response parameters are related to the most recent promotion for that brand as well as for other brands. Events like brand switching, store switching, stockpiling and increased consumption are all better explained with the dynamic model. |
| MacDonald | 2000 | Linear Regression | Studying all purpose flour he investigates why food prices fall at seasonal demand peaks. | Noticing that very few foods have increased prices in their seasonal demand peak and food supply factors are not the cause. Farm to retail margins narrow sharply as well. Finds that market concentration is much larger in markets with several rivals than where a single brand dominates. Seasonal demand increases lowers the effective cost of advertising, and increased information advertising by retailers and manufactures |

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| | | | | may allow for increased market info and great price sensitivity on buyers. |
| Kinoshita & Suzuki | 2001 | LES | Analyze the demand for fresh and reconstituted milk products in Japan. Price-cost margin ratios are used to test different pricing strategies. | Measure price elasticities, and degree of substitutability between fresh and reconstituted milk products. PCM is a Lerner index of each commodity that does not need cost data. Tested different pricing strategies. Found own price elasticities are much more elastic than previously thought. Scanner data allows for greater product substitution. PCM ratios indicate non-collusive behavior. Recon milk is more price elastic making it a better promotion item. |
| Curry et al. | 2001 | Linear | Conducts hedonic regression on TV brands in the UK. Interaction effects are tested. The results are compared to a neural network model with its property of universal approximation. | The use of simple functional forms is out of place for hedonic regressions. Interaction effects do exist between makes and characteristics between individual characteristics for the TV's. For Sony TV's higher level effects do exist. Explanatory power of econometric models does not improve substantially from fuller specifications. Neural networks only slightly outperform OLS estimates in terms of predictive ability. NN does not do a good job of predicting price for a hypothetical TV, but does predict non-linearity departures. |
| Capps & Love | 2002 | Rotterdam | Studies orange juice looking at econometric considerations in using scanner data for demand analysis. Focusing on the aggregation problem using Lewbel's GCCT and weak separability results are compared. | With Lewbels group aggregation augmented Dicky-Fuller (unit root) tests are done to check for non-stationarity. Then cointegration is done, if the commodities are not cointegrated then they are suitable for aggregation. Results show (GCCT) eliminates all departures in elasticities (when estimating a demand subsystem). Implies the number of brands can be reduced without resorting to weak separability. Some additional advantages are covered. |

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| Vickner & Davies | 2002 | VEC Cointegration Model | Conducts analysis and estimates strategic price responses in the herbal and black tea market. | Hypothesis is that multi-market contact may increase the probability of tacit collusion. VEC model measures the price response of rivals in terms of magnitude and speed. Unit root tests determine the order of the price series to be analyzed by FIML. Found that the two top black tea brands were cointegrated and the top black tea brand was cointegrated with the top herbal tea brand. Also found which brands respond to other brands pricing decision and the speed of response. |
| Kinoshita et al | 2002 | Conjectural Variations Model | Studying milk again, they tried to explain pricing in a market which was oligopolistic and characterized with product differentiation. Applied a two product linear Bertrand model using price as the strategic variable. | They calculate own price, cross price and conjectural variations elasticities. See if firms have consistent pricing behavior or if increased consumption of reconstituted milk is lowering demand for domestically produced raw milk. 3SLS is used on a simultaneous 4 equation system. Found that Bertrand model is inappropriate for the empirical analysis. Elasticities were large due to the brand level estimation. CV elasiticities were significant for recon milk implying that consistent pricing behavior could not be statistically supported. |
| Ward et al | 2002 | N/A | Study the private label and national label pricing strategies. Conventional wisdom is that national brands should decrease price increase advertising and increase product differentiation in response to new entry. | Find that private label and generic goods are 2/3 of the quantity share of frozen poultry. Conventional theory is broken because it seems that a monopoly will keep prices low in order to attract new customers but once entry occurs it will increase price lower advertising and perhaps increase product differentiation by essentially selling the same product under a different name. One exception is poultry where private label prices are higher than national brands and frozen poultry's rate of product |

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| | | | | development where share of new items is roughly twice that of deceased items. |
| Dutta et al. | 2002 | VAR (Vector Autoregressive Model) | Studies orange juice and the extent of price rigidity including wholesale prices, in the market distribution channel. | They find flexibility at retail level to cost changes. They respond to their direct costs and also upstream manufacture cost. Intermediate level goods exhibit more rigidity in response to manufactures price and cost changes. Wholesale prices are more ridged. Even if a market appears volatile the price rigidity may be hidden. |
| Chevalier et al | 2003 | Warner-Barsky Rotemberg-Salner, and Loss-leader Models | Examine wholesale and retail price interactions to see why prices do not rise in periods of peak demand. | Find that retail margins fall for foods at their seasonal demand peaks rather than at the aggregate demand peak for the store. Find that prices do not fall in generally high aggregate demand times like Thanksgiving and Christmas, if anything the rise. The data is consistent with loss-leader pricing implying price for goods with idiosyncratic demand peaks. Increased advertising for seasonally peaking items supports loss leader. |
| Dhar et al | 2003 | AIDS | Estimates Marshallian demand functions for soft drinks. Tests for endogeneity of price and expenditure. Can use instrumental variables or explicitly specifying the supply relationship. | Used utility trees to test the different model versions and separability assumptions. Strong evidence for endogeneity of price and expenditure. After correcting for endogeneity own and cross price elasticities became consistent and asymptotically efficient as well. Weak sepaerability is rejected but the strength of evidence against weak separability goes down after correcting for endogeneity. |

## Chapter 3 Model Structure

### 3.1 Introduction

The necessary background before any estimation can take place has been provided in the earlier part of this thesis. In chapter one a general industry overview was given and the objectives of the thesis emerged as being critical for the analysis of the Canadian poultry industry.

In chapter two the arguments supporting the methodology and empirical framework that will be undertaken in chapter 3 was provided. In the literature review consumer theory, different ways to model demand, FAFH, previous meat demand and scanner data papers among other important topics were reviewed. The extensive literature review highlighted the fact that no study on chicken demand in Canada has been conducted at such a disaggregated level.

This chapter will present a detailed conceptual and empirical framework that will be used to complete the study. A description of a two stage AIDS model specific to chicken will be followed by construction of different utility trees for tests of weak separability. Next a complete model will be presented including different variables such as seasonal dummies, elasticity formulas, and a description of the restrictions used.

### 3.2 Consumer Demand for Chicken Products

Meat demand changed considerably in the last thirty years with chicken now being the most popular meat consumed in Canada, for the first time exceeding beef on a per capita basis in 2003 (CFC Handbook, 2003). Changing trends merit a closer study of the poultry industry and the vast array of fresh, frozen, and further processed products that

are offered in today's retail store. Consumers have a limited budget which can be spent on an infinite variety of goods and services, in order to conduct a practical empirical study some simplifying assumptions need to be made. Consumption needs to be logically broken down into smaller decisions which can be modeled in a demand system.

Weak separability is a necessary and sufficient condition for two stage budgeting and it allows for the disaggregation of products into groups where the marginal rate of substitution between goods in the same group is independent of the quantities being consumed in other groups. In the first stage of a multi-stage budgeting process a consumer will allocate income across broad commodity groups such as (food, clothing, shelter etc.). Then in successive stages further allocations of income within the broad commodity groups are made until the decision gets down to individual commodities. The stages of the decision process are conducted as if it was a simultaneous utility maximization procedure (Deaton and Muellbauer, 1980).

The study of Canadian chicken demand will be based on the assumption that in the first stage chicken is separable from all other goods and at the second stage it is separable from all other meats, these are maintained assumptions. The dependant variable in the first stage of the demand system is specified as the log of total expenditure on chicken as a function of a set of logged independent variables such as prices of the different chicken products, other meats, personal disposable income, and seasonal dummy variables (the seasonal dummies are not logged). The general form of the first stage total expenditure equation is:

$$TEXP_i = \sum P_i Q_i = f(PSTAR,PB,PP,INDEX,PDI,BSE,TEXP(-1),SD)$$

$i = 1,2,\ldots,n.$ individual products

$P_i =$ real price of individual chicken products i

$Q_i$ = quantity consumed of chicken product i
PSTAR= expenditure share weighted price index for all types of chicken products

PP= price of pork
PB= price of beef
INDEX= food safety index
PDI= personal disposable income
BSE= BSE dummy variable
TEXP(-1) = lagged total expenditure one period
SD= seasonality dummy variables

Variables will be dropped in estimation based on significance of variable coefficients and to obtain significance and correct signs on critical variables such as price. The expenditure weighted price index (P) is a Stone price index and is linear facilitating easier estimation of the AIDS model. The scanner data provides very detailed price and quantity information for specific products, with many products, so simplifying aggregations are made to make the dataset manageable. The basic aggregated groups in the fresh and frozen categories are estimated in the second stage of the demand system. In the second stage it is a maintained assumption that chicken is separable from all other meats so that when the decision has been made to buy chicken the consumer is only faced with different product choices consisting of chicken. At the second stage of the model a system of share equations illustrating the demand for each type of chicken product as a function of the goods own price, prices of other chicken products, total expenditure, seasonal dummies and time. Other variables such as the food safety index, BSE, can also be included and tested.

$$w_i = P_iQ_i/TEXP = g(P_i, TEXP, SD, Time) \quad i = 1,2,\ldots,n. \text{ individual products}$$

The broad categories of chicken products are frozen (further processed) and fresh. Brand information exists for all of the frozen products and some of the fresh. The remaining fresh chicken is generic and is not given a brand name in the dataset. It is far too complicated to attempt estimation of a demand system for all the products with their respective brands so major chicken product categories are estimated instead. Many of the products are relatively new and were not offered for sale during some period in the data and other specific products were discontinued over the estimation period. Therefore, estimation will be attempted on the major product groupings highlighted by the AC Nielsen data. In both the fresh and frozen categories, variables are created that take into account products that do not fit well in any of the defined categories. These variables are titled *mix* (short for mixture) in the frozen group, and *ast* (short for assorted) in the fresh group.

### 3.3 Utility Trees

Studying consumer behavior can be challenging since so much choice exists on how a person can spend their income. The assumption when conducting a demand model is that we are studying a representative consumer. Modeling the decision process on how a consumer purchases different goods has implications for how to aggregate products together and to what extent they should be left disaggregated. Weak separability of goods at the second stage and a homothetic utility function at the second stage of the demand system are necessary conditions for two stage budgeting.

There are many ways that a person could be making the decision to consume a particular chicken product, so it is worthwhile examining possible utility decision trees. The purpose of the utility tree is to partition commodities into groups so that preferences

within groups can be described independently of quantities in other groups (Deaton and Muellbauer, 1980). Each grouping has its own subutility function, a grouping may contain only one good or a subutility function can have more sub-grouping embedded in it. Individual subutility functions contain their representative commodities and join up together to form a tree. The utility tree suggests two-stage budgeting where at the first stage allocation is possible knowing total expenditure and appropriate group prices, and at the second stage individual commodity expenditure must be a function of group expenditure and prices only within that group (Deaton and Muellbauer, 1980). The entire process of maximizing the subutility functions is a sequential process where the result must be identical to what would occur if the allocation was done in one step with complete information.

Previous studies by (Eales and Unnevehr, 1988) and (Nayga and Capps, 1994) break down chicken products into whole birds and fresh plus further processed parts, and breasts, parts, and other chicken respectfully. Since our study only looks at chicken a more detailed breakdown is possible. The following table provides a summary of the variable names and abbreviations plus the number of individual chicken products that were aggregated to form that variable.

**Table 3.1. Table of Aggregated Chicken Product Variables from the ACNielsen Scanner Data.**

| Product Group | Variable Abbreviation | Percent Share of Total Chicken | Number of Individual Products | Frozen or Fresh |
|---|---|---|---|---|
| Premium priced breaded formed chicken | PBFC | 4.5% | 76 | Frozen |

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|---|---|---|---|---|
| Value priced breaded formed chicken | VBFC | 0.8% | 13 | Frozen |
| Breaded natural chicken | BNC | 1% | 31 | Frozen |
| Flavored chicken breasts | FCB | 0.5% | 28 | Frozen |
| Un-flavored chicken breasts | UFCB | 2% | 30 | Frozen |
| Chicken wings | WNGS | 3% | 64 | Frozen |
| Stuffed chicken | SC | 0.3% | 11 | Frozen |
| Un-breaded chicken burgers | BUGU | 0.5% | 15 | Frozen |
| Breaded chicken burgers | BUGB | 0.9% | 25 | Frozen |
| Breaded chicken parts | PART | 0.08% | 13 | Frozen |
| All other frozen chicken | MIX | 1.2% | 56 | Frozen |
| Whole chicken | whole | 21% | 56 | Fresh |
| Breast | brst | 24% | 116 | Fresh |
| Drumsticks | drum | 7.7% | 28 | Fresh |
| Wings | wing | 4.2% | 33 | Fresh |
| Burger | burg | 0.08% | 3 | Fresh |
| Legs | legs | 13% | 33 | Fresh |
| Winglettes | wingt | 0.1% | 4 | Fresh |
| Kabobs | kabob | 0.3% | 4 | Fresh |
| Nuggets | nugg | 0.06% | 4 | Fresh |
| Drumettes | drumt | 0.5% | 6 | Fresh |
| Thighs | thigh | 7.7% | 39 | Fresh |
| Fresh chicken remaining | ast | 5% | 85 | Fresh |

Source: AC Nielsen 2003.

Due to the small size of some categories in the fresh products they were combined with other larger product groups. For instance drumettes + winglettes were put in the wing group and fresh chicken halves and chicken quarters were placed in the assorted group. It should be noted that mechanically separated meat for products such as hot dogs and deli meat are not included in the scanner data. The share equation used in previous studies would have been expressed as $w_{chicken} = f(p_{chicken}, p_{beef}, p_{pork}, TEXP)$ where the p's

are prices of the different meats and TEXP is the total expenditure on meats. In order for chicken to be aggregated together the assumption has to be made that all the prices for the individual parts move together in the same proportion. This assumption may be too strong considering the demand profile for chicken has changed dramatically in the last 30yrs. In 1976 people only ate ~16kg of chicken per year, today they eat double that and much of the increased demand has come from further processed products which add value by offering consumers convenience in meal preparation. Retail stores also sell more individual parts so that consumers can choose the part they like best. The price differences between higher demand white meat and lower demand dark meat parts can be staggering and price fluctuations do not always move in the same direction or proportion, in fact white meat prices have been going up while dark meat prices have gone down.

When constructing utility trees only goods that are substitutes can be placed in the same group. This is because separability conditions require that the marginal rate of substitution (MRS) between a specific group of goods be functionally independent of quantities in other groups of goods (Nayga and Capps, 1994). At the lowest stages of the utility tree individual expenditure must be functions of group expenditure and prices within the group alone (Deaton and Muellbauer, 1980). One possible utility tree is with the maintained assumption that chicken is separable from all other meats:

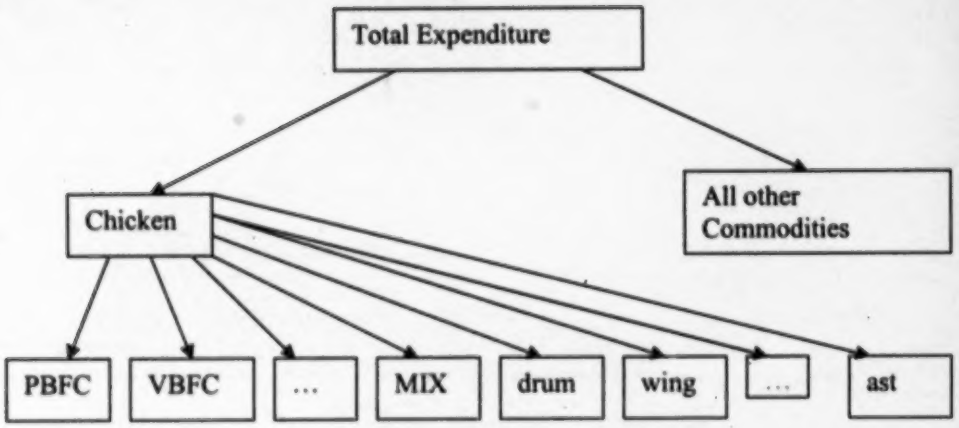



**Figure 3.1 Utility Tree For Chicken Products (1)**

In this case once the consumer has decided to purchase chicken at the grocery store he is faced with 23 different types of products. This model assumes that fresh and frozen chicken are substitutes. Other types of decision processes are also plausible for example the decision to purchase chicken may also include a FAFH option:

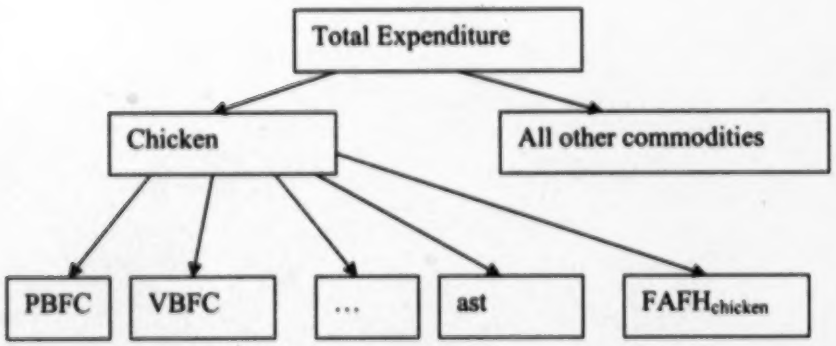



**Figure 3.2 Utility Tree For Chicken Products (2)**

However, the decision to consume FAFH may be independent of the decision of what to consume when eating out. Implying that the decision to eat out is made long before the choice of what type of chicken to buy is made. So chicken consumed at the retail store may be independent of that eaten at the restaurant.

Another possibility could involve recognizing a distinction between the fresh and the frozen products at the store. Once the decision to purchase chicken is made the consumer chooses between weakly separable groups of fresh and frozen product.

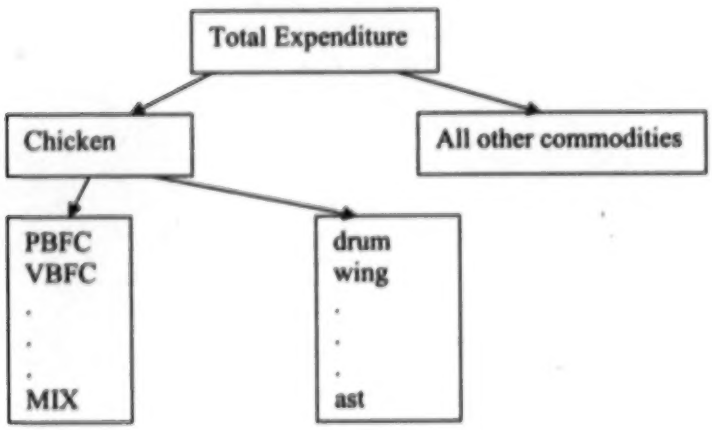



**Figure 3.3 Utility Tree For Chicken Products (3)**

Many other utility trees are possible depending on which products are considered substitutes. Our model will test for separability as well. Weak separability is a necessary and sufficient condition for two stage budgeting (Deaton and Muellbauer, 1980).

### 3.4 Weak Separability

Weak separability restrictions have been rejected in past empirical work perhaps due to the highly aggregated level that the studies were conducted at (Nayga and Capps, 1994). If separability restrictions are not consistent with the true preference ordering of the consumer, estimates of the model parameters will be invalid. Tests for weak separability can be parametric or non-parametric, in this study parametric tests will be used since they are conditional to functional form and lend themselves to statistical testing (Nayga and Capps, 1994). If the direct utility function is weakly separable then commodities belonging to the same group may be aggregated, therefore separability can be used to justify commodity aggregation. The necessary and sufficient condition for weak separability is that the off diagonal terms in the Slutsky substitution matrix must be proportional to the income derivatives of the two separable goods. Following (Goldman and Uzawa, 1964) if goods i and j are in separable groups C and D then:

$$S_{ij} = \theta^{CD} \frac{\partial Q_i}{\partial TEXP} * \frac{\partial Q_j}{\partial TEXP} \quad \text{for all } I \in C \text{ and } j \in D \text{ and } C \neq D$$

$S_{ij}$ = the appropriate element in the Slutsky substitution matrix
TEXP = total expenditure
Q's = are the quantities consumed
$\Theta^{CD}$ = a factor of proportionality between groups C&D thus measuring the degree of substitutability between the two groups

The above equations suggest that weak separability places no restrictions on substitution of goods within the same group, substitution between goods in different groups occurs only through group expenditure and a factor of proportionality characterizing the inter-group relationship. From the above equation an actual test can be developed where; if i and j are in group C and k in group D then:

$$\frac{S_{ik}}{\partial Q_i/\partial TEXP} = \frac{S_{ik}}{\partial Q_j/\partial TEXP} \quad \text{for all } i,j \in C \text{ and } k \in D$$

the actual restrictions when put into the AIDS model look like:

$$\gamma_{ik}(\beta_j + \omega_j) - \gamma_{jk}(\beta_i + \omega_i) + (\omega_i\beta_j - \omega_j\beta_i)(\omega_k - \beta_k \ln(TEXP/P)) = 0$$
$$\text{for all } i,j \in C \text{ and } k \in D$$

If these restrictions are rejected it implies that the data does not support the structure of a particular tree. If we fail to reject the restrictions it implies that the aggregation of a specific tree may exist. A likelihood ratio test can be used to test the robustness of the model by determining whether the other variables in the model such as seasonality, BSE, food safety, and others actually improve the model or if by having them present reduces the models performance. The test is given as follows:

$$\Psi = -2[LR_R - LRu_R]$$

where $LR_{UR}$ are values of the unrestricted log-likelihood function and $LR_R$ are values of the restricted log-likelihood function, and $\Psi$ follows a $\chi^2$- distribution with a degree of freedom equal to the number of restrictions.

### 3.5 The Complete AIDS Model

Many different functional forms can be used to estimate demand and can produce different results and policy implications. However, it is also true that choice of functional form can be a matter of preference. Although meat demand scanner data studies can use any type of functional form the Rotterdam model (Nayga and Capps, 1994) and the AIDS model (Eales and Unnevehr, 1988) are two common ones. The AIDS model is a good choice since it is a flexible functional form so it is less restrictive than the LES and is better at dealing with disaggregated commodities (Deaton and Muellbauer, 1980). The

AIDS model satisfies the axioms of consumer choice perfectly and allows for consistent aggregation of the micro level demands all the way up to a market-level demand function (Eales and Unnevehr, 1988). Additive preferences are not necessary in the AIDS model. The general structure of the 2-stage AIDS models share equation is:

$$\omega_i = \alpha_i + \Sigma_j \gamma_{ij} \ln (p_j) + \Sigma_k q_{ik} SD + J_i Qt(-1) + K_i safety + F_i BSE + B_i TEXP + X_i Time + \beta_i \ln(TEXP/P)$$

where $\omega_i$ = expenditure share on the $i^{th}$ commodity
$p_j$ = are commodity prices
SD= seasonal quarterly dummy variables
Qt(-1) = lagged quantity
Safety = food safety index
BSE = BSE dummy variable
TEXP = total expenditure
TIME = time

and

$$\ln(P) = \alpha_0 + \Sigma_j \alpha_i \ln(p_i) + \tfrac{1}{2} \Sigma_i \Sigma_j \gamma_{ij} \ln(p_i) \ln(p_j)$$

is a price index. Applying the basic demand restrictions of homogeneity, adding up, and symmetry directly on the parameters of the model we get:

| | |
|---|---|
| $\Sigma_i \alpha_i = 1 \quad \Sigma_i \gamma_{ij} = 0 \quad \Sigma_i \beta_i = 0$ | adding-up |
| $\Sigma_j \gamma_{ij} = 0$ | homogeneity |
| $\gamma_{ij} = \gamma_{ji}$ | symmetry |

which can be tested or imposed.

The model is fairly linear except for the P which is often hard to estimate econometrically since in a model as disaggregated as this one is, many of the prices are probably co-linear. Therefore, the ln(P) will be approximated with the Stone Index $\ln(P) = \Sigma \omega_k \ln p_k$ to avoid the simultaneity problems. The model is estimated with an iterative

seemingly unrelated regression with the last share equation dropped because of the adding up restriction.

### 3.6 Elasticities

From the estimated coefficients a number of useful and informative elasticities can be calculated. Price elasticities tell how much quantity demanded changes for a 1% increase in price. Both own and cross price elasticties are represented by the following formula for price elasticities at the second stage.

$$\frac{\partial \omega_i}{\partial p_j}\frac{p_j}{\omega_i} - б \qquad (б=1 \text{ for } i=j \text{ ; } б=0 \text{ for } i\neq j)$$

All own price elasticities should be negative and significant. It is useful to calculate the price elasticities across both stages of the model as well since the formula takes into account total expenditure (assumed endogenous) on all retail chicken.

$$\frac{\partial \omega_i}{\partial \omega p_j}\frac{p_j}{\omega_i} + \left(\frac{\partial \omega_i}{\partial TEXP}\frac{TEXP}{\omega_i} + 1\right)\frac{\partial TEXP}{\partial p_j}\frac{p_j}{TEXP} - б \qquad (б=1 \text{ for } i=j \text{ ; } б=0 \text{ for } i\neq j)$$

Expenditure elasticities at the second stage of the model tell how much the budget share for a certain product changes with a 1% increase in total expenditure.

$$\frac{\partial \omega_i}{\partial TEXP}\frac{TEXP}{\omega_i}$$

Because of the imposition of homogeneity all these elasticities will be 1 since ($\partial\omega_i/\partial TEXP=0$). When constructing expenditure elasticities across both stages it is important to recognize that in a two stage demand model with homogeneous separability, homotheticity needs to be imposed. Homotheticity is when the indifference surface for a

given group of goods are homothetic to the origin. Homotheticity is a necessary condition for consistent 2-stage demand modeling. The general form of the expenditure elasticity across both stages is:

$$\frac{\partial \omega_i}{\partial TEXP} \frac{TEXP}{\omega_i} + 1$$

With homotheticity imposed all of these elasticities will be the same for different commodities in the same group. Substitution elasticities are also calculated at the 2nd stage of the model:

$$\frac{\partial P_i}{\partial \omega_i} \frac{\omega_i}{P}$$

its purpose is to measure the degree of substitutability between goods, if the expenditure share of a good increases the substitution elasticity will tell what happens to the price of other goods. All own substitution elasticities should be negative. These results are useful in constructing marketing simulation experiments.

### 3.7 Estimation Procedure

Since the data is time series some potentially serious problems may exist. According to Green (2003) times series data is often autocorrelated so that the variation around the regression function is related from one period to another. Therefore, the model is estimated with autocorrelation corrections built in to avoid this problem. The model is estimated using SUR and maximum likelihood procedures. The program used for conducting the estimation is TSP version 4.5.

## 3.8 Summary

This chapter covered the methodology used for the thesis estimation. Besides estimation of the AIDS model other statistical tests for weak separability and the log likelihood ratio test serve to provide support to the proposed model structure. The different types of elasticities will be useful in constructing simulation models and discovering properties of disaggregated chicken product demand. The next chapter will take an in depth look at the scanner data to analyze major trends that exist for the twenty three different chicken product groups as well as some trends in the other data that is used in the model.

## Chapter 4 The Data

### 4.1 Overview of the Scanner Data

This chapter will examine the data used for estimation of the AIDS model in greater detail with AC Nielsen weekly scanner data that was provided for the Canadian retail chicken market. The data on chicken parts retail price, quantity, and value were given for many individual fresh and frozen products. Originally the fresh items quantity variable was stated in kilograms and the frozen items were given in pounds, this was the first inconsistency in the data so all frozen items quantities were converted into kilograms allowing the retail price in both data sets to be expressed in $/kg. The second inconsistency was regarding the data time span; fresh items started to be recorded the week of October 14, 2000 and ended the week of November 1, 2003. Frozen items started on November 11, 2000 and ended the week of November 23, 2003. In order to create a consistent dataset only perfectly overlapping weeks were used so that the dataset for the model ended up being from November 11, 2000 to November 1, 2003 for a total of 156 weeks. All of the products for the frozen subgroup were branded but in the fresh subgroup both branded and generic product are included. The individual product list illustrates the sheer volume of products, 411 fresh and 311 frozen items of various brands, and package size were aggregated to form 11 and 12 commodity groups respectfully (see Table 4.1). The aggregation of the individual products occurred by totaling the quantity and value and dividing by the number of products to get price in order to form one aggregated commodity group representing similar types of chicken products. In the creation of the product or commodity groups it was necessary to be as consistent as possible with the original structure of the Nielsen data. The twenty three

commodity groups estimated in the model are essentially the same as the original breakdown in the data with a few minor adjustments. As mentioned in the previous chapter some of the product categories are too small particularly on the fresh side to estimate on their own so winglettes + drumettes were placed with fresh wings and chicken halves as well as quarters were placed in the fresh assorted category. A potential drawback of this type of aggregation is it ignores the fact that package size sometimes matters in determining the price of chicken. Usually the larger the package size the less expensive the meat is on a per kg basis. By aggregating large and small package sizes together it ignores the potentially different demands that exist for bulk consumption. Another drawback is that certain product groups especially on the fresh side contain items that are slightly different in form, this is evident for breast and thighs because many are boneless, skinless, contain both or neither and consumers may have strong preferences for a certain type of product. Some of the more subtle differences within product groups cannot be captured which can be looked upon as both a drawback but also an advantage. Estimating at a more disaggregated level is not done since the structure of demand systems simply does not allow it, there are limits to how many products can be estimated. However, the scanner data is detailed and if a market researcher was interested in a particular commodity group they could estimate a more detailed system just on breasts for example, or if the group was small enough even brand level estimation is possible. Since the scanner data is national in scope regional differences in demand cannot be discovered and also some of the individual items may not be sold in all regions of the country. Figure 4.1 illustrates that price differences exist for the same product in different regions of the country. Compared to aggregate disappearance data which

contains no product disaggregation, scanner data provides greater insight into some of the more intricate aspects of the demand profile at the retail level.

### 4.2 General Consumption Trends for Fresh and Frozen Chicken

Before estimating it would be interesting to examine some of the basic trends and descriptive statistics for each of the twenty three product groups to see if any predominant trends or predictions can be made about the results. From the aggregated per capita disappearance data it is evident that total chicken consumption is increasing but since food service is taking an increasing share of the meat dollar it is necessary to examine retail consumption trends for fresh and frozen chicken. Examining Figure 4.2 the weekly trend in frozen processed chicken consumption; a significant upward trend in total amount consumed even over the short time period of the data can be seen. From the trend line it can be seen how in every week consumption of frozen chicken has been increasing by about 784 kg. Since much of the new product development is concentrated in this area the upward trend is not surprising but still relatively small compared to the upward trend in fresh chicken consumption as illustrated in Figure 4.3. The level of fresh chicken consumption is much higher than frozen where every week's consumption increases in total by ~2843 kg. Other important factors may be driving fresh chicken consumption such as relative prices compared to other meat, health concerns etc, where for frozen chicken time may be important since people could be still discovering many of the products.

In terms of quantity, fresh chicken comprises 85% of the retail market and frozen chicken only accounts for 15% as illustrated by Figure 4.4. Frozen chicken is a diverse and dynamic area where many of the products are focused on convenience and include

microwavable dinners like "cordon bleu", "kiev", and other marinated and breaded products. Very little frozen chicken is in a raw unprocessed form such as frozen utility birds. Another important observation is that except for wings, burgers and perhaps some specific products in the MIX category almost all frozen chicken is white meat. From Figure 4.5 many interesting trends are discovered. Except for very small categories on the fresh side like winglettes, kabobs, nuggets, and burgers almost all of the commodity groups on the frozen side are smaller than any commodity group on the fresh side. Frozen wings and premium priced breaded formed chicken are the two largest groups on the frozen side and breasts are the largest category on the fresh side illustrating white meats high demand. Surprisingly whole birds still make up the second largest commodity group at 21% of total retail chicken. On the graph value share was placed right beside quantity share to see if the two are proportional to one another; generally they are not. Only for certain products like frozen burgers, parts, and mix do they exist in equal proportion. For every commodity group except value priced breaded formed chicken the value shares are greater then the quantity shares. This may be because many of the frozen products are white meat which is the higher valued meat also people are paying for additional convenience. On the other hand, most fresh commodity groups except for breast meat, kabobs, and winglettes have quantity share exceeding value share. Major dark meat categories like legs, thighs, and drums, have this trend. Whole birds are a mixture of white and dark meat so it has been somewhat unclear as to how consumers perceive this category judging from the relationship of quantity share to value share it seems to be consistent with the perception of a dark meat product.

The average price (unit values) for the twenty three different chicken products vary greatly, where frozen further processed items are higher priced as compared to fresh (see Table 4.2). The price for dark meat is lower then the price of breast meat indicating that the demand profile for these two meats and their associated products could differ substantially.

### 4.3 Frozen Further Processed Chicken Products

By graphing quantity and price for each of the twenty three commodity groups individually over the time period of the data more subtle trends can be discovered which could give insights into a commodity specific marketing strategy for chicken. Since premium priced breaded formed chicken (PBFC) is the largest group on the frozen side it is important to analyze (see Figure 4.6). As for most of the quantity trends there is a high degree of variability from week to week which could mean that demand is elastic and highly responsive to price changes or that quantity available for purchase on a week to week basis may be variable the product may also be frequently used as a sale item. By examining the price and quantity lines it appears that they move in opposite directions in lock step. When there is a sudden increase in quantity the price drops and when there are periods of low quantity the price tends to rise. This is consistent with the way a supply and demand function work together where if quantity supplied goes up and demand remains the same then price has to drop. By including trend lines on top of the price and quantity lines we can see if the trends are consistent with the larger subgroup. For PBFC the quantity trend is slightly increasing and the price trend is slightly decreasing. Although the quantity trend is consistent with frozen chicken in general the price trend is

not. There could be many reasons for this but consumers available choices for new products many be prompting the stores to lower price on this flagship commodity group.

Value priced breaded formed chicken (VBFC) shows some peculiar quantity trends (see Figure 4.7). It appears that around the end of the year and the beginning of the new year quantity increases by about 20000 kg but then drops suddenly and then increases gradually until about September when supplies seem to be at their lowest. One possible explanation for this rhythmic pattern could be that after Christmas a large supply of whole birds or perhaps chicken in general may exist and stores or processors try to dispose of it by making more breaded chicken products. It might be value priced because some of the products may be dark meat or mixed dark and white and the package size tends to be larger then that of PBFC. The quantity trend on average is slightly increasing and the price trend is stable with no wild price fluctuations even though the quantity fluctuations are erratic. The price trend is definitely upward sloping increasing about $1/kg from the beginning of the sample to the end.

For frozen breaded natural chicken (BNC) price and quantity fluctuations are roughly proportional (see Figure 4.8). Both the price and quantity trend are slightly decreasing over the sample period. Many of the products in the BNC are white meat and so price per kg is fairly high around $12/kg.

Flavored chicken breast (FCB) exhibits a slight downward price trend and a slight upward quantity trend (see Figure 4.9). One important point to note which has implications on the trend lines, is that in May of 2002 there was a sharp one time increase in quantity from a stable 20000 kg to an incredible 130000 kg in a period of one or two weeks. This resulted in a $8/kg drop in price. Prices and quantities quickly stabilized

again but in the last half of 2002 quantity seemed to fluctuate considerably moving up and down in the same fashion. There is no easy explanation for that one time surge in supply but one thing that is illustrated is how price sensitive this group is. Since flavored chicken breasts are white meat it may be hypothesized that this item is more price elastic than other white meat.

Frozen unflavored chicken breasts show a very erratic supply pattern which is maintained throughout the year (see Figure 4.10). Supply jumps ~175000 kg every three months or so. After every sharp jump quantity supplied falls almost as quickly as it rises, remarkably when the supply jumps occur price does not drop by very much. Compared to flavored chicken breasts unflavored chicken breasts price is fairly stable implying that the demand for un-flavored is more price elastic then dark meat as well.

The average price for frozen wings (WNGS) are around $11/kg with a fairly flat price trend overall (see Figure 4.11). Quantity supplied moves up and down over longer periods of time and can be quite erratic. The general quantity trend for frozen chicken wings is upward sloping consistent with total frozen chicken. The price for this product is high and illustrates that the right marketing strategy plays an important role dictating the price that can be obtained for the meat.

One of the most peculiar price trends in the entire dataset is that of stuffed chicken (SC) (see Figure 4.12). It appears that after September 2001, the price of stuffed chicken increased and persistently stayed high even though quantity supplied has fluctuated to points below what was experienced before the price increase. Before the increase SC price was stable and averaged around $12/kg and after the price increase it stabilized around $18/kg. This observation is not inconsistent with what restaurants say

was an increase in demand for comfort food after 9-11. People did not want to go out to restaurants as much and were looking for restaurant type food at the retail store. Stuffed products consists of products like kiev, cordon bleu and highly processed fancy products which are usually served at higher end eating establishments. Retailers anticipating a rise in demand for this particular product group may have raised price. Even though the price jump was in conjunction with a roughly proportional drop in quantity, price remained high and stable even though quantity fluctuations were wide in late 2002. Sharp increases in quantity did not drop price very much indicating that demand may be fairly elastic and perhaps went more elastic after 9-11 then before. This is the only commodity group where a pattern like this exists.

The demand for un-breaded chicken burgers (BUGU) is highly seasonal (see Figure 4.13). The quantity demanded is wave like throughout the year. The lowest demand points occur at the beginning of the year where quantity drops below 10000 kg but by the time June and July come demand increases three times to over 35000 kg. Prices do not fluctuate very much in conjunction with the seasonal trend but there is a slight increasing price trend over the sample period. The seasonal consumption pattern is not surprising considering that as the weather gets warmer more outdoor cooking occurs and people who do not like beef burgers might look to chicken as a healthier alternative.

The same type of seasonal patterns that occur for un-breaded chicken burgers are not present in breaded chicken burgers (BUGB) since people do not usually BBQ breaded meat (see Figure 4.14). The quantity and price trend is increasing, averaging just under $9/kg at the end of the data set.

Frozen chicken parts (PARTS) exhibit a very steep decreasing trend over the time frame of the data from about 6000 kg in 2000 to almost nothing in 2003 (see Figure 4.15). Price can be quite responsive to supply shocks as illustrated by two major ones that occurred in 2002 but the price trend overall is only slightly increasing even with the dramatic drop in supply towards the end of the sample. This product category is a type of miscellaneous group that is a combination of white and dark meat products such as "banquet drums and thighs." Actually many of these products could be dark meat and if that is the case then it is surprising why quantity supplied would be going down since relative to other dark meat products the price is about $4-5 more. This product category has potential for development since the country may be in a dark meat surplus, and some of the products in this group give clues to what kinds of further processing potential exists for dark meat.

Nothing too specific can be said about the all other frozen chicken (MIX) category since it is made up of a wide variety of products like sweet and sour chicken, backs, livers, etc most of the products are made up of dark meat and there is a general increasing price trend in a time when the consumption trend was flat (see Figure 4.16). Quantity fluctuations are wide in this category probably because of its miscellaneous nature. Before any specific implications about dark meat marketing can be made this commodity group would have to be looked at more closely. Some of the dark meat products were in the 2-4 kg package range, which is bulk by retail standard. However, with a steep increasing price trend some might speculate that the potential to develop further processed products from dark meat may be good.

**4.4 Fresh Chicken Products**

The quantity trend for whole birds (whole) is variable with the largest supply shocks that seem to occur in late February-March (see Figure 4.17). No seasonal trends are evident from the graph even though one would expect more whole bird consumption in the fall. With the marketing of chicken today being focused heavily on individual parts it would be expected that the demand for whole birds be down but there is a slight positive consumption trend over the sample period. Factors such as price of whole birds relative to other meat and even other chicken products may be causing people to eat more whole birds. For a family with a tight food budget whole birds are a sensible choice and depending on how the chicken is prepared it can be cooked as a series of individual products. Certain members of the family might prefer one of the meat types and buying whole birds allows everybody to get what they want.

Studying the graph for fresh breast meat (brst) it is evident that people favor this product and consistently demand this product group, in many weeks over 1 million kg is sold (see Figure 4.18). The general trend is upward but the supply week to week can be variable. In relation to the quantity spikes, price spikes and dips are not as extreme indicating demand could be elastic and not highly sensitive to changes in quantity. A flat price trend exists where a price per kilogram around $11 occurs throughout the dataset. This group contains boneless-skinless, bone-in, skin-on and every other combination in between so it is important to keep in mind that boneless-skinless is the most expensive with an average price of $13/kg and bone-in, skin-on is the least expensive. Since skin contains large amounts of saturated fat and calories and bones make the meat less flexible for preparation, boneless-skinless chicken breast offers consumers positive heath

attributes with convenience in cooking. The combination of health and convenience characteristics makes boneless-skinless breast meat the most expensive chicken product in terms of fresh chicken.

Drumsticks (drums) are a classic dark meat product and the price is less than half that of breast meat (see Figure 4.19). Some surprising features of the graph is that both the quantity and price trends are upward sloping. Quantity is variable but price does not tend to fluctuate widely. Consumers may be attracted to this commodity group since processors are starting to experiment with it. Maple Leaf for example launched boneless-skinless drumsticks in 2003 and skinless drums have been around for a longer period of time. Selling dark meat without bones and skin appeals to consumers who are still looking for convenience and versatility of the meat but who perhaps do not like the texture and dryness associated with white meat.

Chicken wings (wing) are in favor with most consumers (see Figure 4.20). In the past wings were one of the lowest valued parts of the chicken but in the early 1990's bars and restaurants started to prepare them with Louisiana Hot Sauce and called them Buffalo wings. The popularity of Buffalo wings spread rapidly and consumers also started to prepare wings at home more often, as a result the popularity of the product raised the quantity demanded and its price. Wings are a high value product with an average retail price of ~$6.50/kg. Over the time period of the data the quantity trend has increased by about 50000 kg per week but the price trend has only shown a very small downward slope. Fresh wings can also come pre-marinated and consumers seem to still be demanding more of this product.

Fresh chicken burger (burg) is a very small product category and since there was a massive quantity shock in May of 2003 the trend lines cannot be trusted (see Figure 4.21). For some reason that spring quantity supplied increased 3.5x from 3000 kg to 9000 kg but then stabilized at ~6500 kg near the end of the dataset. After the quantity shock price dropped by about $1/kg or so, since this commodity group is small and new it would need to be observed over a longer period of time. From the product list it is impossible to tell if the burgers are made from white or dark meat but judging from its price it is probably dark meat. It is important to note that this product category is actually burger patties and one was pre-cooked and the other was breaded, etc, these items have some further processing and are not ground chicken meat which is raw and relatively unprocessed. More will be said about ground chicken when the "assorted" category is covered.

Chicken legs are the lowest priced of all the dark meats with a price ~$2.60/kg (see Figure 4.22). A slight positive quantity and price trend exist but nothing dramatic. For consumers on a tight budget legs offer incredible value since it is sold with a drum, thigh and sometimes, the back will still be attached. With a small amount of preparation at home a large quantity of boneless, skinless meat can be made from chicken legs. Even though processors have been experimenting with this commodity group by seasoning, breading and removing the skin legs have not enjoyed large quantity or price gains like wings, thighs, or even drums. Perhaps because of the large size of the legs consumers have a harder time preparing it and so they opt for purchasing smaller pieces that are more manageable.

The wings (wing) of a chicken contain three pieces (1) winglette (2) drumette (3) tip (see Figure 4.23 & Figure 4.26). Recently the trend in the food service industry has been to sell chicken wings in its pieces without the tip. They may do this for a number of reasons for instance; it may be more appealing to the consumer who does not have to go through the messy process of splitting the wing in half in order to eat it. Also restaurants may be able to substitute between winglets and drumettes and purchase whichever is cheaper and still be able to call it chicken wings. It would be a good idea to study whole wings and individually sold pieces at the same time since they are the same body part but the demand profiles differ. Both winglettes (wingt) and drumettes (drumt) are small product groups relative to whole wings so it would be interesting to see if the separate parts popularity will increase over time. The price for winglettes is lower then the price for whole wings by about $1-2/kg and the trend is downward. Drumettes in comparison have an average price $2/kg higher then whole wings and the price trend is increasing. The drumette is the part in higher demand and also has the most quantity of meat with price being 3x that of winglettes. Winglettes have very little meat compared to drumettes and are mostly made up of skin, so it is not surprising demand for drumettes is higher at the retail level but that is not necessarily true at the restaurants. Also in terms of cooking it is easy to overcook winglettes making them too crispy and hard but drumettes are more tolerant of over baking or cooking. In terms of convenience food and further processing drumettes appear to have good potential but whole wings are still the dominant form sold at the store. With respect to price sensitivity winglettes are less sensitive then drumettes which can experience fluctuations up to $1/kg from week to week.

Fresh kabobs (kabob) are another small product group and with an average retail price of $12.19/kg this would appear to be a white meat product (see Figure 4.24). All kabobs are boneless and some are seasoned. A kabob is cubes of meat sold on a long stick often interchanged with vegetables and designed for barbequing. As a result the seasonal trends are extreme with almost no demand in the winter and a large demand in the summer. Price is relatively stable however and kabobs have an increasing quantity trend implying that people may be searching for more beef substitutes in the BBQ season.

Nuggets (nugg) are breaded but in this case not frozen (see Figure 4.25). In May of 2003 their was some very erratic quantity fluctuations and price dropped from $7/kg all the way down to ~$3/kg. Even before quantity became highly variable price seemed to be highly sensitive to small changes in quantity implying that own price demand could be inelastic. This product category is the smallest of all so speculating on general trends may not be useful. Judging from the price of this group the meat type could be white but is most likely dark since the price never goes above $10/kg which is the minimum for a white meat product.

Fresh thighs (thigh) are a group that is quite diverse in form just like breast meat with all kinds of bone and skin combination options with price differentials existing between the forms, but with aggregation all thighs are treated the same (see Figure 4.27). Thighs are a product that is often sold in "club pack" form where price can be much lower than if small packages are purchased. The quantity and price trend mirror the general trend for fresh chicken both being upward sloping. Quantity spikes tend to occur at the beginning of the year but prices tend to be stable with no large fluctuations even when quantity spikes.

The last commodity group is an assorted category (ast) which contains a wide assortment of products like backs, fillets, halves, and giblets which do no fit well into any other group (see Figure 4.28). One area of interest is ground chicken which is contained in the (ast) category. Ground chicken should perhaps be put into its own group since it is common at every grocery store and makes up a sizable contingent of this category. Ground chicken is interesting because it can come in two different forms, lean ground is usually ground thigh meat but can be ground breast meat. Ground chicken made from white meat is sold at a premium but both types could be a substitute for ground beef. With the discovery of BSE this product category should be examined closely to see if consumers would be willing to switch towards ground chicken if the warnings about BSE escalate. However, since the Nielsen data left ground chicken in the assorted category it will not be removed to maintain consistency. These twenty three commodity groups are the individual products that are estimated in the demand system.

**4.5 Major Subgroup Comparisons**

Stepping back and observing what larger trends are important, first a comparison was made between fresh and frozen product prices (see Figure 4.29). PBFC and whole birds are the representative products for the frozen and fresh categories respectfully. From the graph it can be seen that frozen chicken is about $3-4/kg higher than fresh chicken and the prices tend to move together with a positive correlation coefficient of 0.23. Another distinction was made within the fresh subgroup between white and dark meat (see Figure 4.30). Legs and breasts were used as the representatives and the graph clearly illustrates the price differential between the two. Dark meat legs are ~$/kg lower in price than breast meat. A negative correlation coefficient of -0.04983 implies that the

two product prices do not always move together. If the price of breast meat goes up dark meat price can go down. If this is the case then the substitutability between the two meats may not be strong. If they were good substitutes then as white meat price increases so should dark meat price since people would buy more dark meat raising its price in the short term. Perhaps a complementary relationship exists between the two.

If the demand for white meat is larger then dark then the question to be raised is what the consumption trend for dark meat is in general? (see Figure4.31). Over the time period of the data the trend is positive so demand is increasing but not as fast as fresh meat in total implying that the demand for white meat is increasing faster than the demand for dark in Canada.

**4.6 Other Data in The Model**

In order to complete the demand model other information besides the price of chicken has to be included. Other data used in the model include personal disposable income, population, consumer price index, price of beef, price of pork which are all obtained form the CansimII database. Since the data was weekly seasonal dummies were hand constructed where (January-February-March) is considered winter, (April-May-June) spring, (July-August-September) summer, and (October-November-December) the fall. While other seasonal breakdowns are possible this particular one captures both Thanksgiving and Christmas in the fall, historically a time when more bird meat is consumed. A food safety index was created by counting all of the newspaper articles relating to E.coli, Salmonella, or Campylobacter organisms that are commonly associated with chicken meat and food preparation. Any articles relating to these three organisms are thought to be negative in nature and potentially turns consumers away from chicken or

certain types of chicken products, however it is important to note that no specific product recalls occurred for chicken over the time period of the data. The newspaper articles where only the ones that appeared in Canadian publications over the time period of the data excluding French language newspapers in Quebec. The Canadian Newsstand and Factiva databases were used to conduct the search. Some of the weeks had no articles on either of the organisms but in other weeks the level of activity was high (See Figure 4.32).

The BSE outbreak was a major event in Canadian agriculture which occurred within the timeframe of the data. In order to see if any changes in chicken consumption occurred a dummy variable was included for the pre and post BSE weeks. Weeks before May 24, 2003 were denoted with a zero and after May 24, 2003 weeks were denoted with a one.

Table 4.2 CansimII Data Sources For The AIDS Model

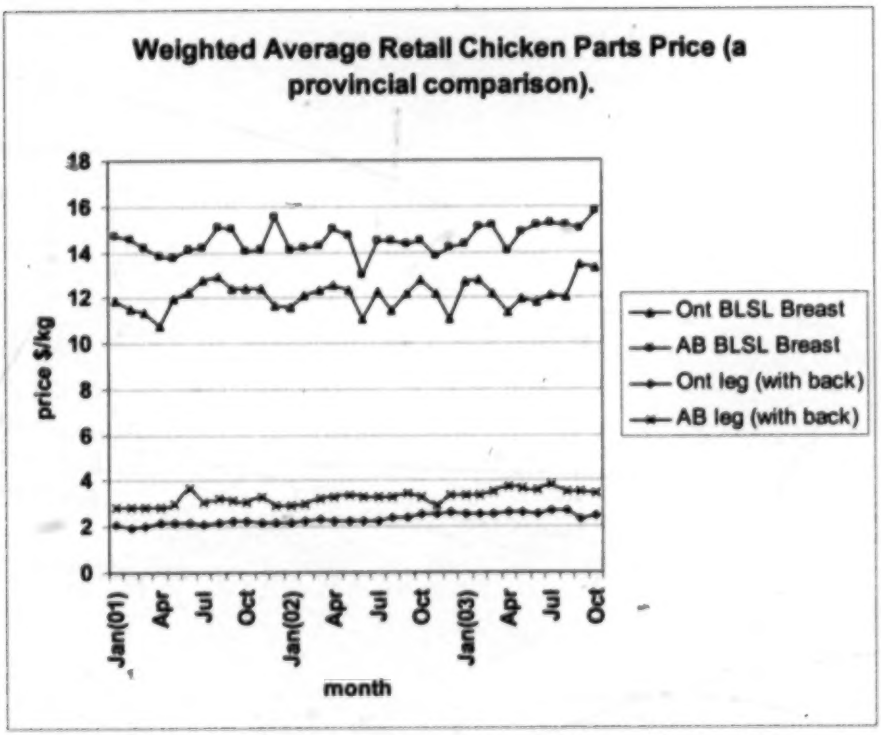
| **Data Variable** | **Series #** | **Table #** |
|---|---|---|
| Personal Disposable Income | V647037 | 3800019 |
| Population | V1 | 510005 |
| Consumer Price Index | V36394 | 1760003 |
| Price of beef | V735187 | 3260012 |
| Price of pork | V735221 | 3260012 |

The population trend was increasing through the study period increasing by almost one million people. Personal disposable income has also been increasing from $623,472,000,000 in November, 2000 to $702,000,000,000 by November 2003. When taking population growth into account per capita disposable income increased from $20,250 to $22,134. The CPI exhibits a general increasing trend along with the price of beef but the price of pork fluctuated greatly during the study period.

## 4.7 Summary

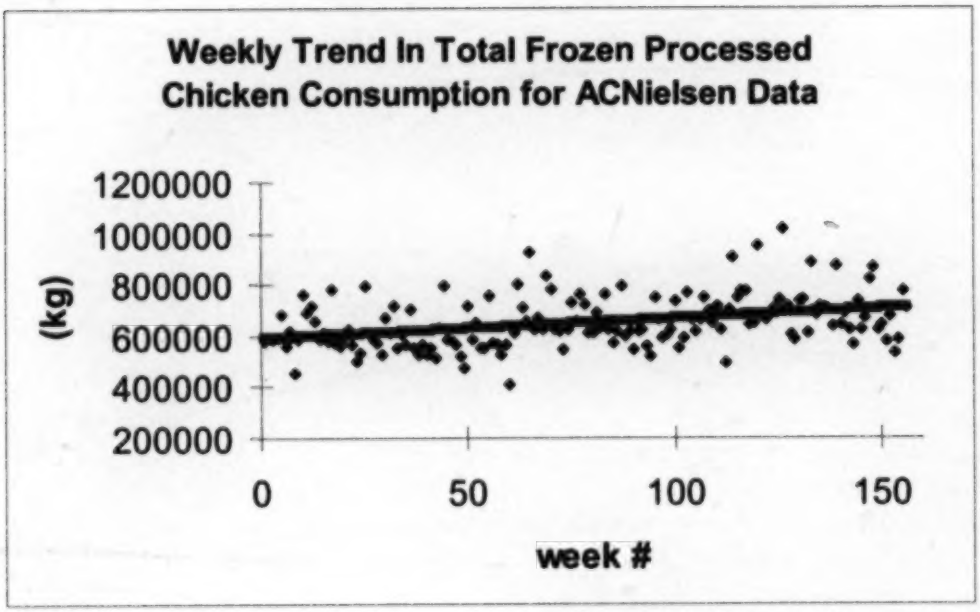
All of the data outlined above is necessary for the AIDS model estimation. Scanner data can be very volume intensive and some type of aggregation system is necessary to make estimation possible. Keeping the original structure of the data intact seems like a logical approach. If a more detailed study is needed then it would need to be analyzed at the single product level with multiple brands. Although a more aggregated model could be estimated keeping as many product groups separate as possible allows for a more comprehensive estimation and adds to the uniqueness of the study. The next chapter will discuss the results of the estimation in detail in order to discover the intricate relationships that exist between the different chicken products in the grocery store, and also to see if some of the statements made about the commodity groups made in this chapter is supported by the demand system results.

Figure 4.1



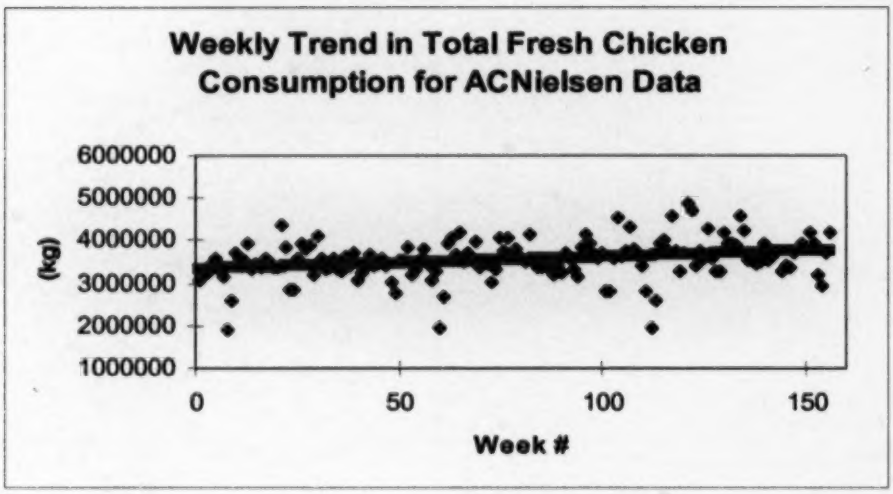

Source: Agriculture Canada Poultry Market Review 2003

Figure 4.2



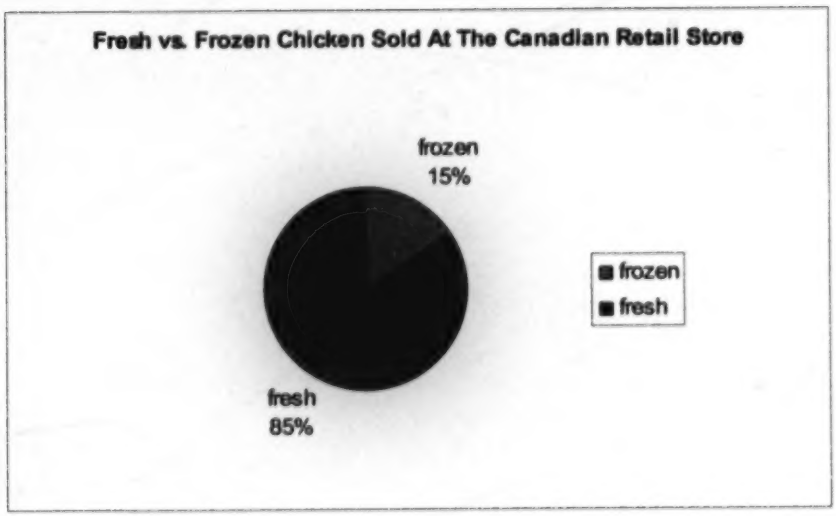

Source: ACNielsen 2003

Figure 4.3




Source: ACNielsen 2003

Figure 4.4




Source: ACNielsen 2003

Figure 4.5

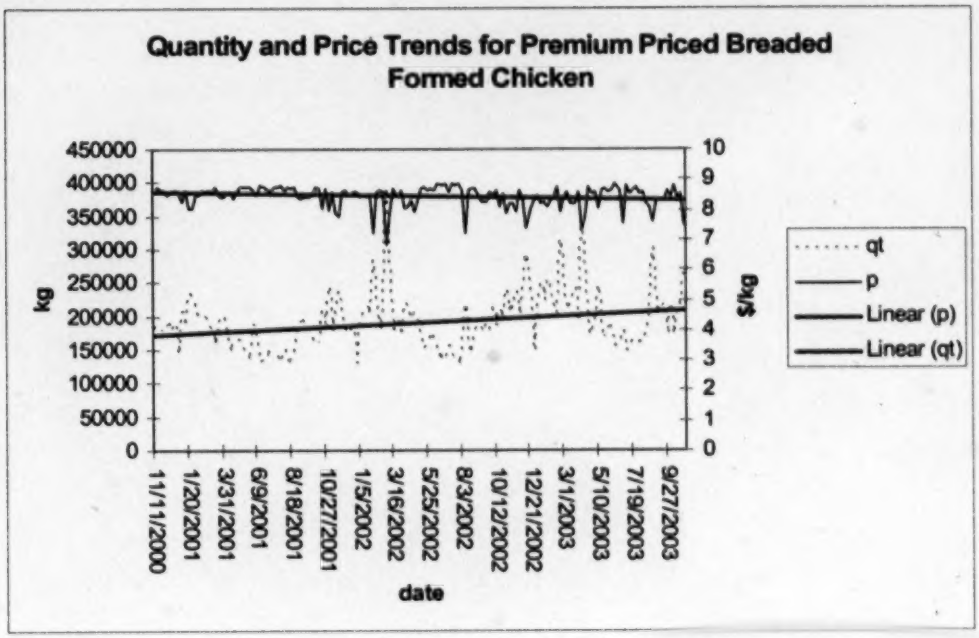
Source: ACNielsen 2003

Table 4.1 Average Retail Price for Twenty Three Commodity Groups Estimated in the AIDS Model.

| Product | Product Number | Fresh/Frozen | Retail Price $/kg |
|---|---|---|---|
| Premium Priced Breaded Formed Chicken (PBFC) | 1 | Frozen | 5.57 |
| Value Priced Breaded Formed Chicken (VBFC) | 2 | Frozen | 4.79 |
| Breaded Natural Chicken (BNC) | 3 | Frozen | 12.20 |
| Flavored Chicken Breasts (FCB) | 4 | Frozen | 12.28 |
| Un-flavored Chicken Breasts (UFCB) | 5 | Frozen | 10.34 |
| Chicken Wings (WNGS) | 6 | Frozen | 10.93 |
| Stuffed Chicken (SC) | 7 | Frozen | 15.72 |
| Un-breaded Chicken Burgers (BUGU) | 8 | Frozen | 5.82 |
| Breaded Chicken Burgers (BUGB) | 9 | Frozen | 8.34 |
| Chicken Parts (PART) | 10 | Frozen | 10.06 |
| All other Frozen Chicken (MIX) | 11 | Frozen | 7.69 |
| Whole (whole) | 12 | Fresh | 5.09 |
| Breasts (brst) | 13 | Fresh | 11.06 |
| Drumsticks (drum) | 14 | Fresh | 4.28 |
| Wings (wing) | 15 | Fresh | 6.50 |
| Burger (burg) | 16 | Fresh | 5.43 |
| Legs (legs) | 17 | Fresh | 2.79 |
| Winglettes (wingt) | 18 | Fresh | 5.35 |
| Kabobs (kabob) | 19 | Fresh | 12.19 |
| Nuggets (nugg) | 20 | Fresh | 7.20 |
| Drumettes (drumt) | 21 | Fresh | 8.48 |
| Thighs (thigh) | 22 | Fresh | 5.71 |
| Assorted Fresh (ast) | 23 | Fresh | 5.57 |

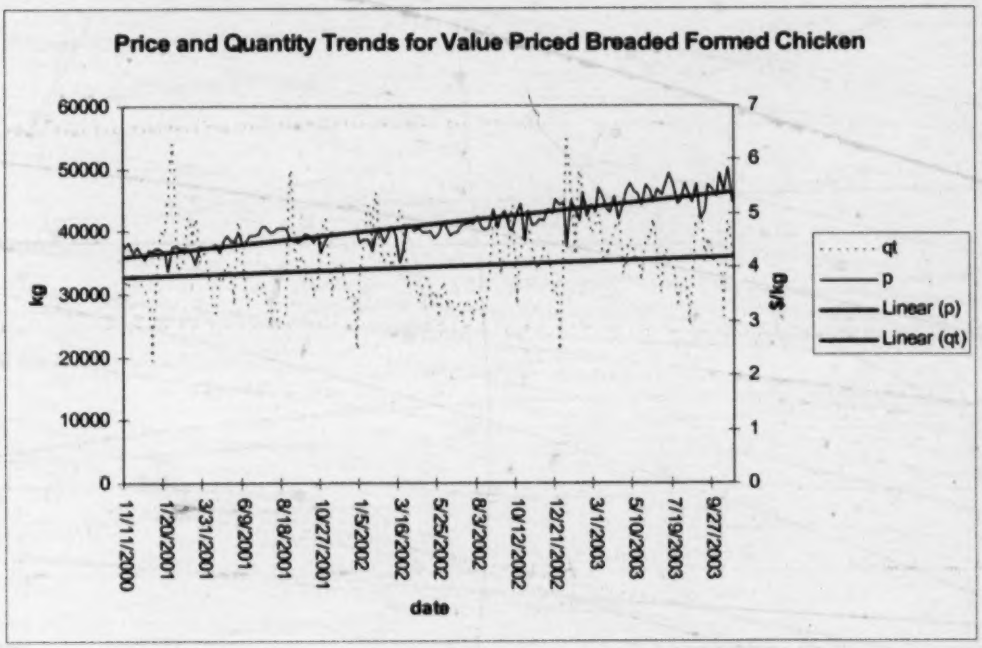
Source: ACNielsen 2003

Figure 4.6




Source: ACNielsen 2003

Figure 4.7

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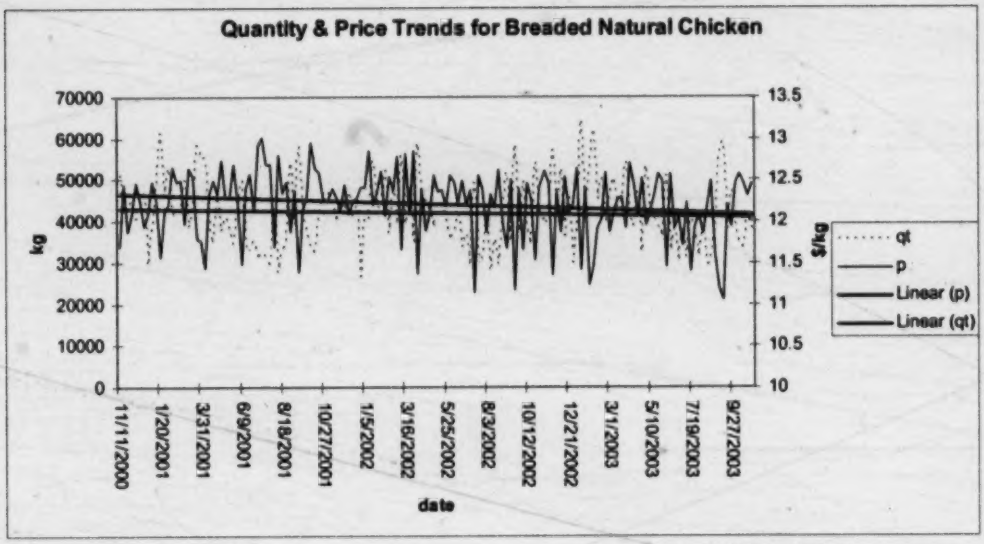


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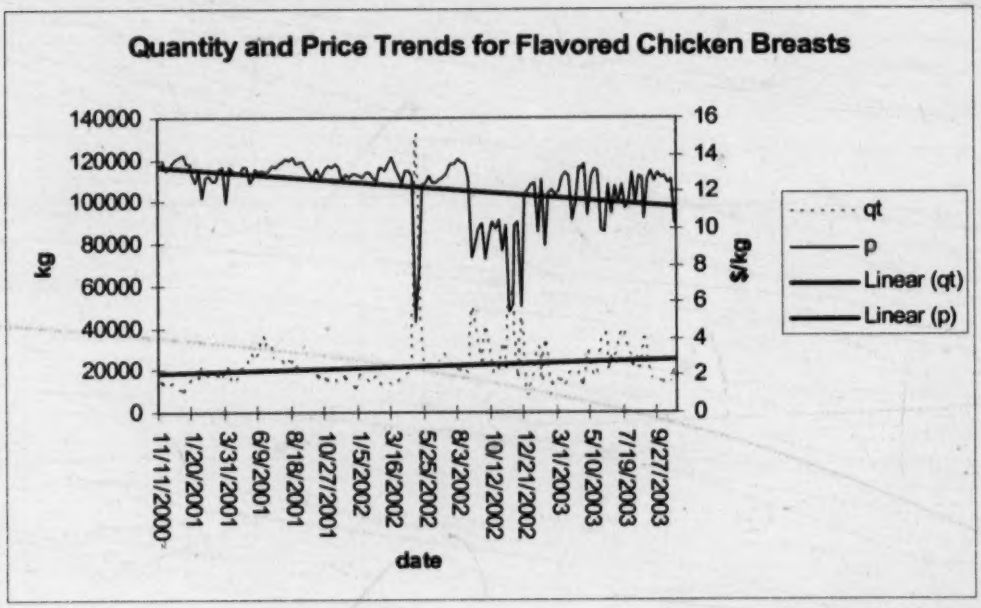


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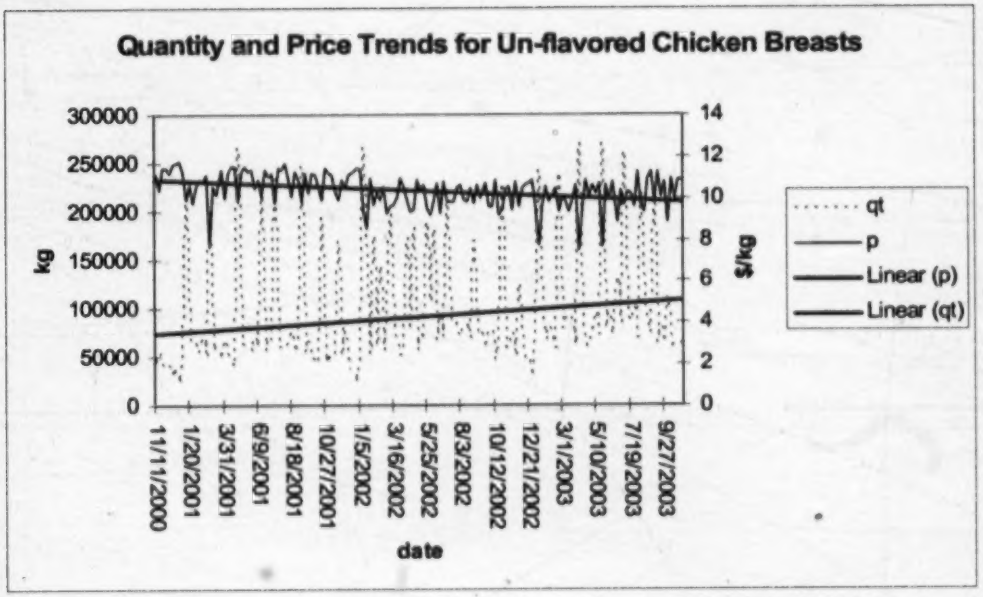


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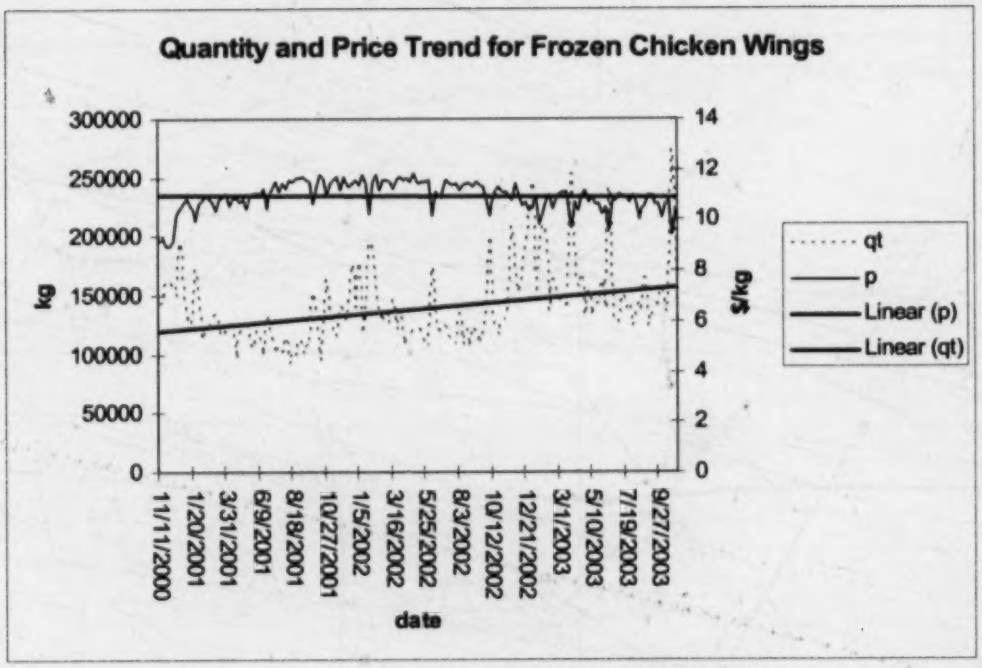


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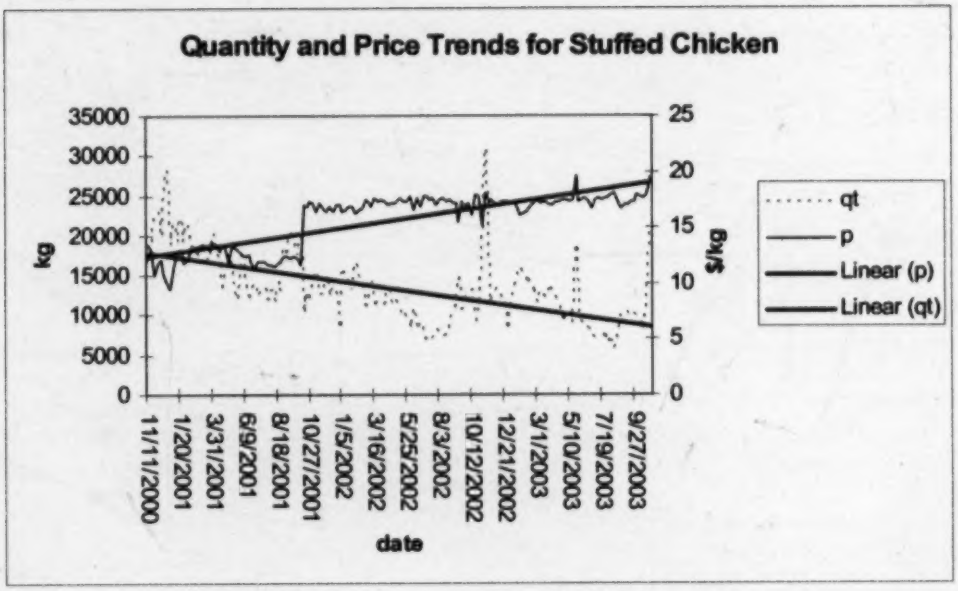


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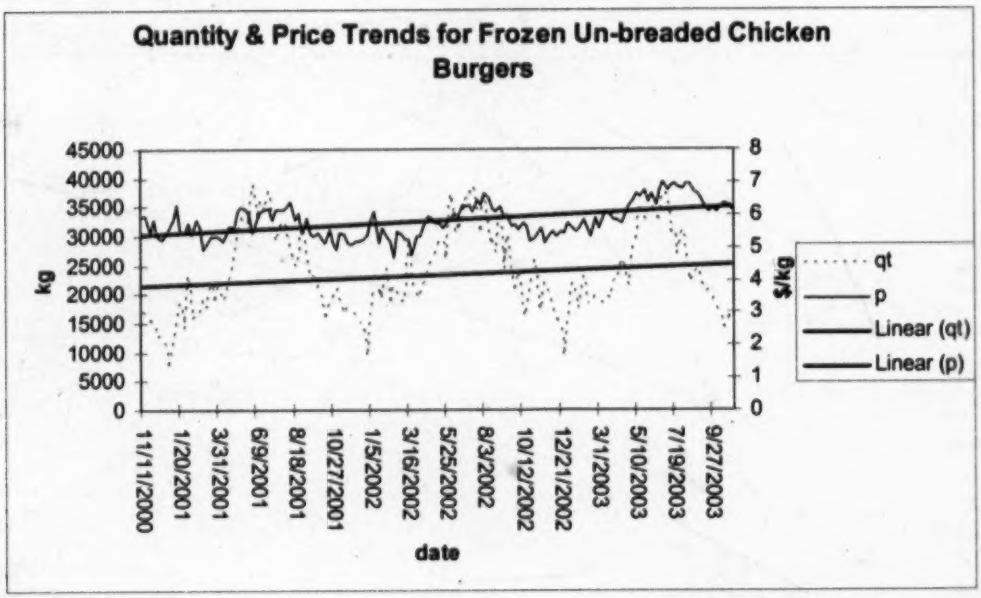


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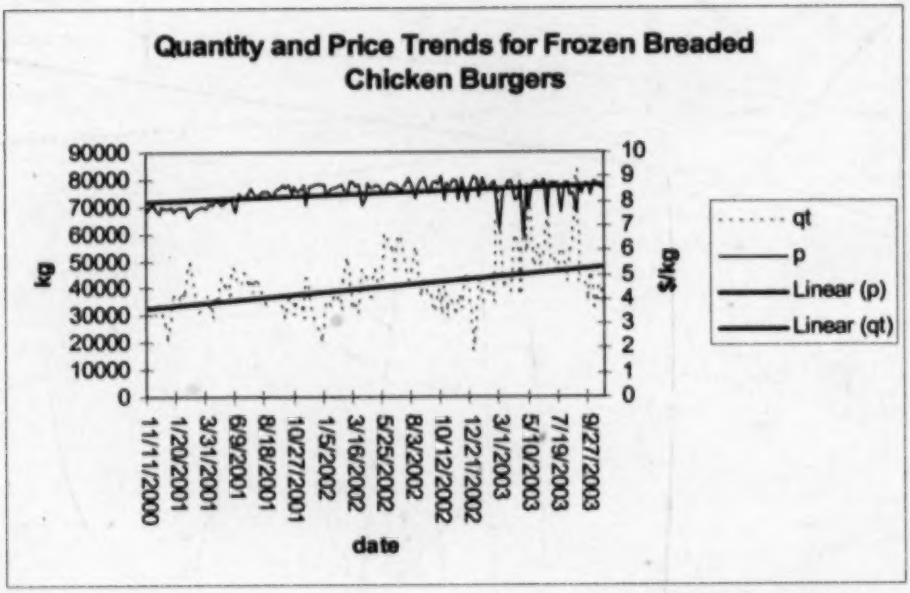


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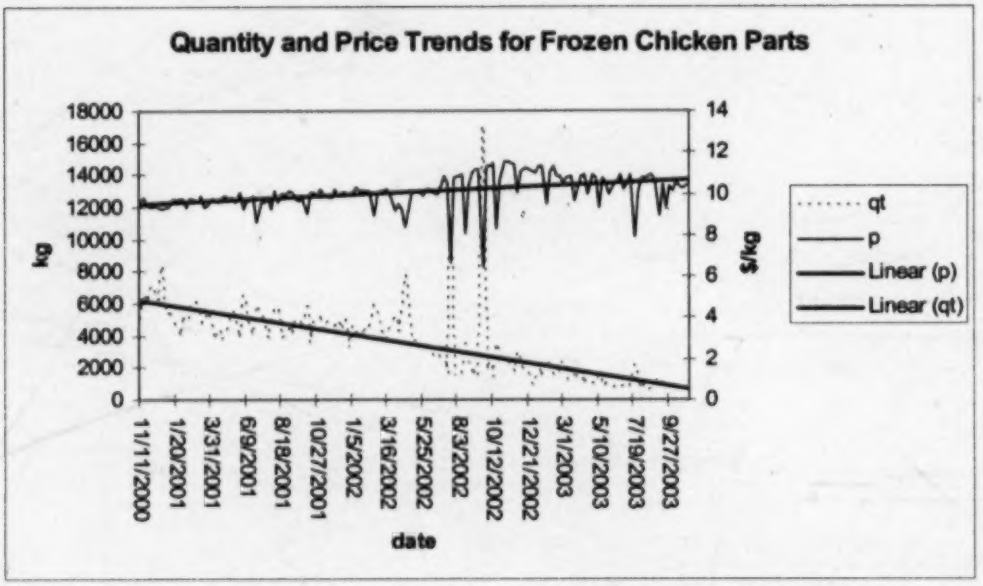


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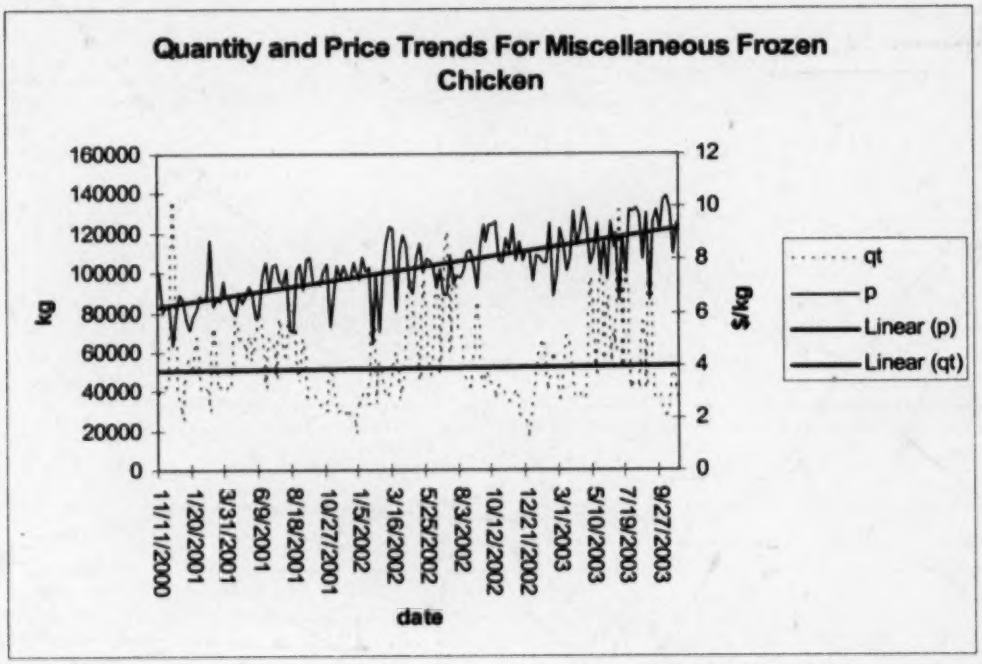


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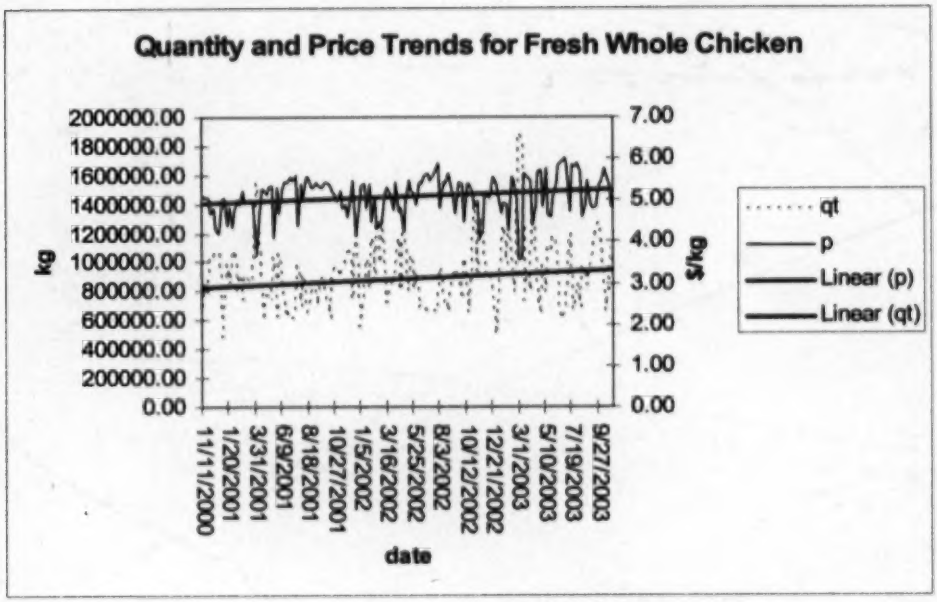


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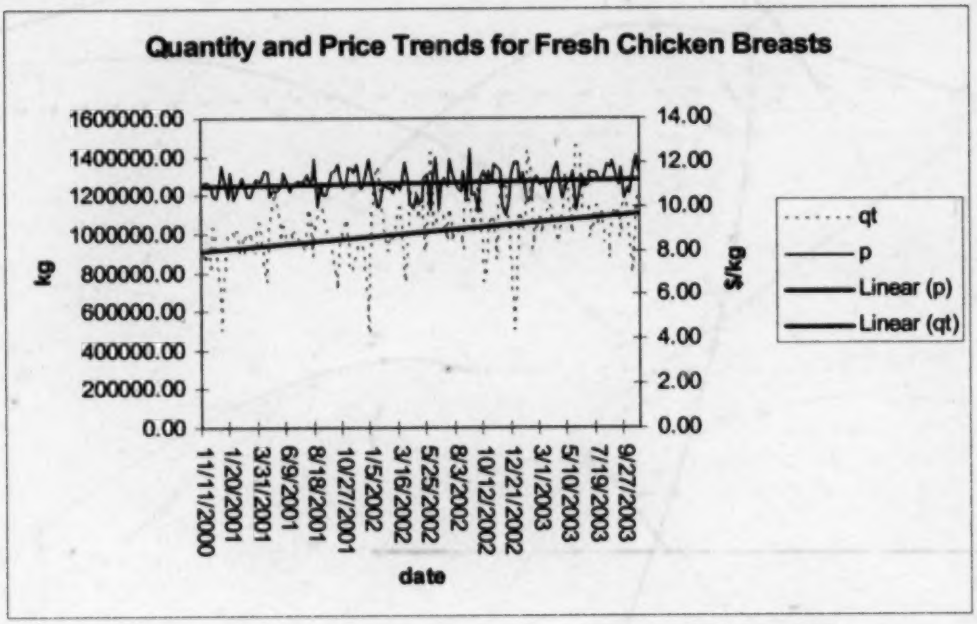


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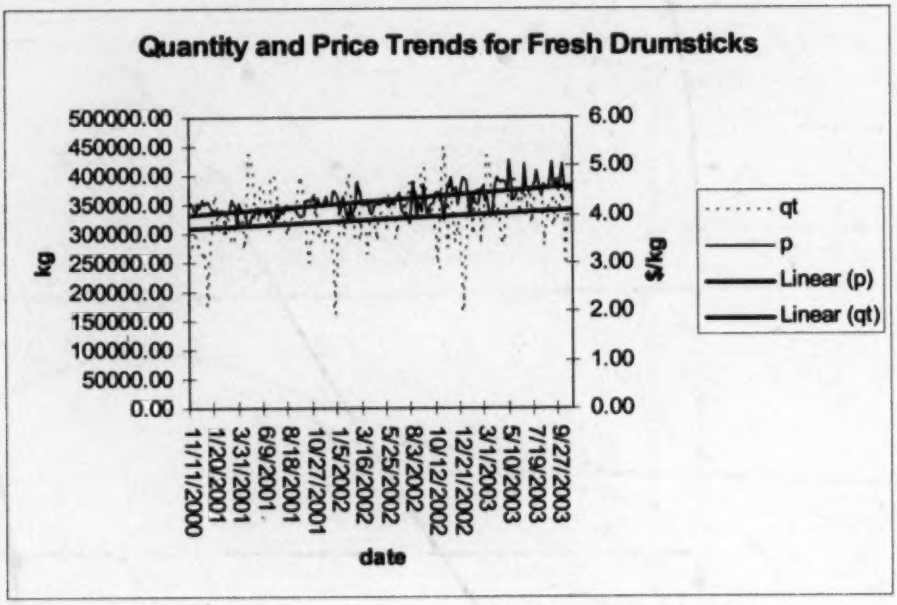


Source: ACNielsen 2003

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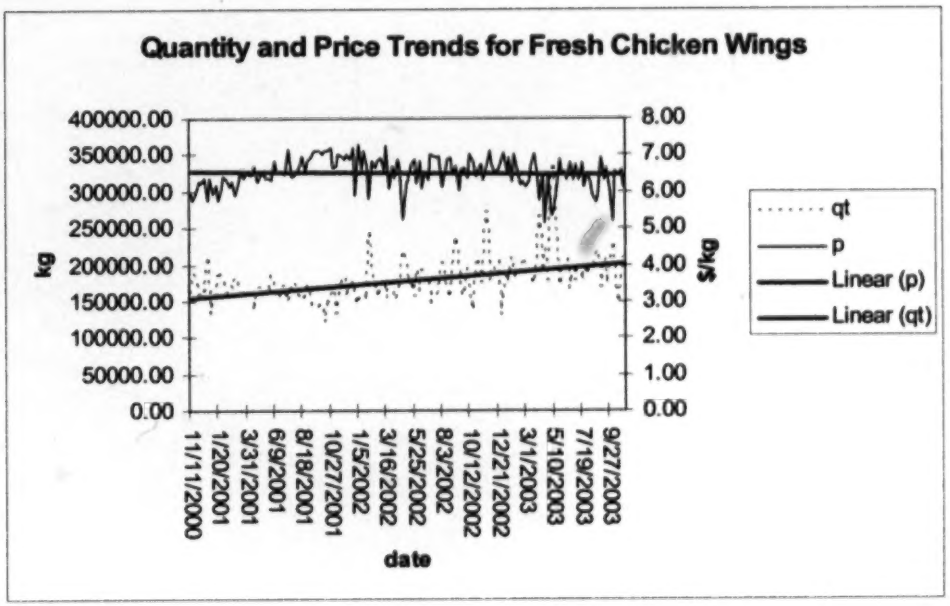


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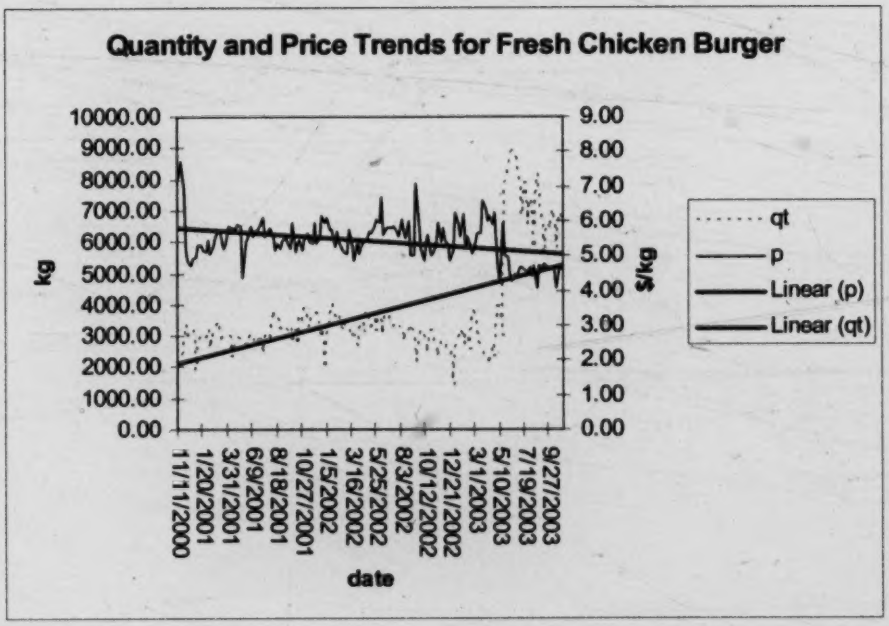


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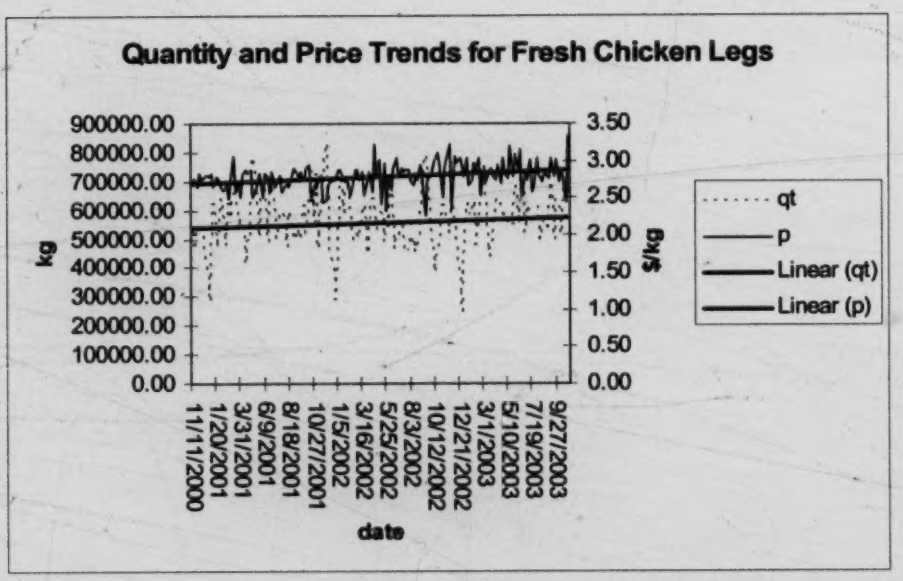


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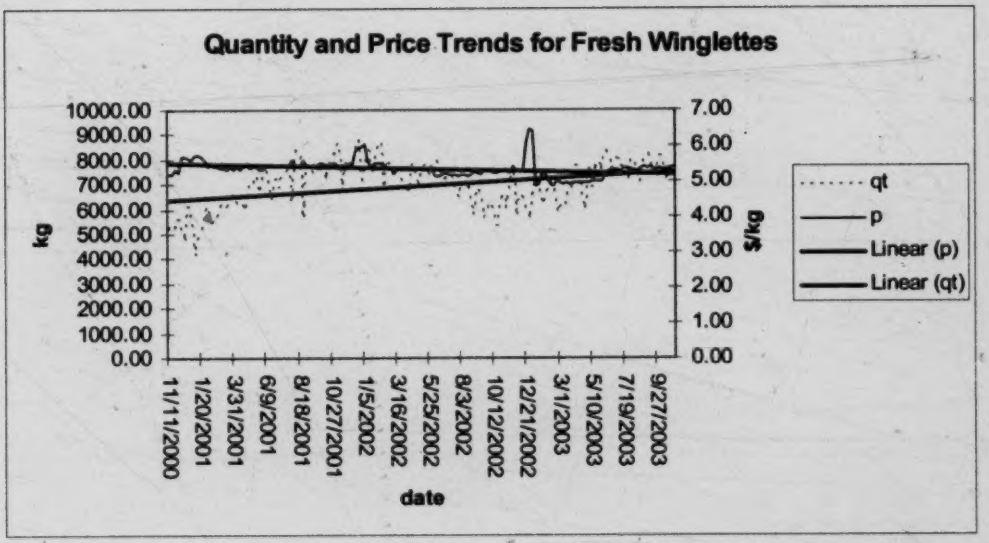


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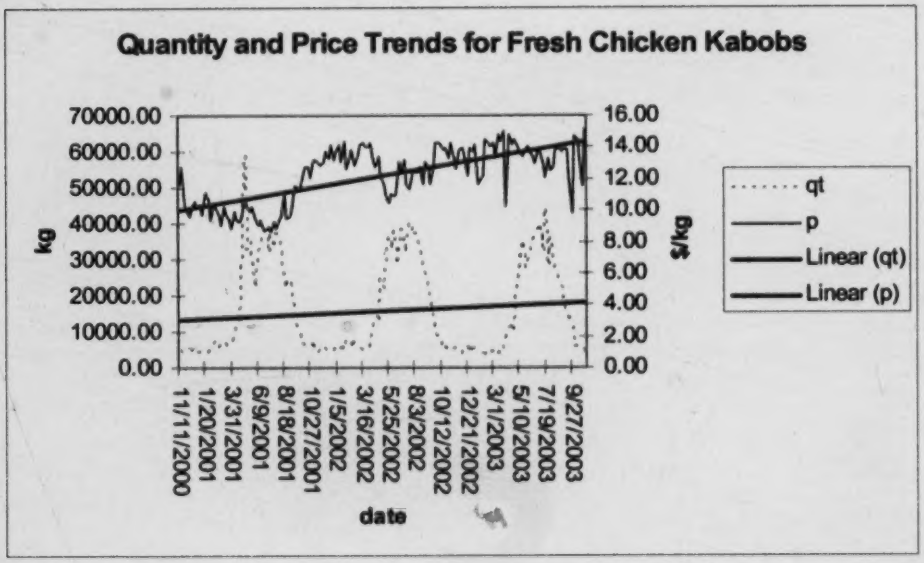


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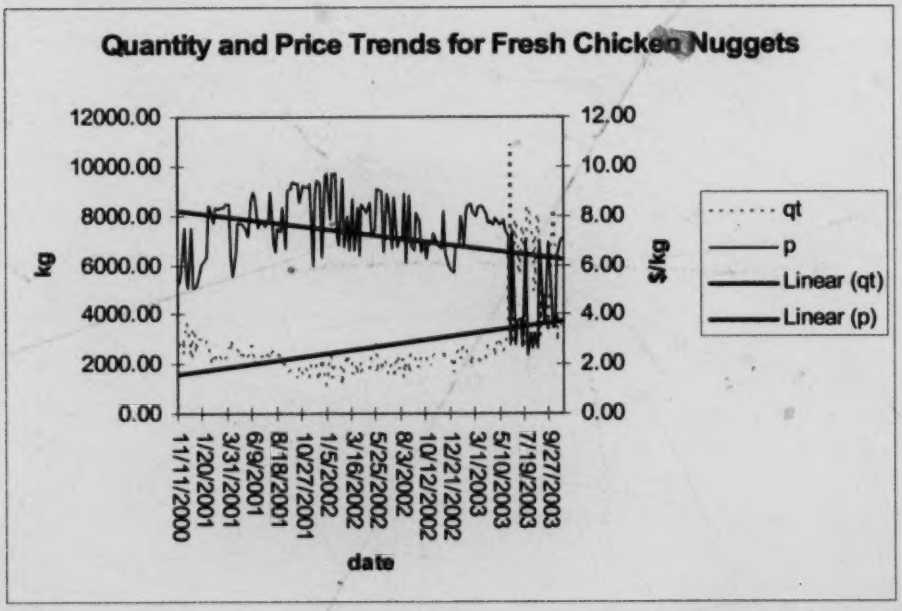


Source: ACNielsen 2003

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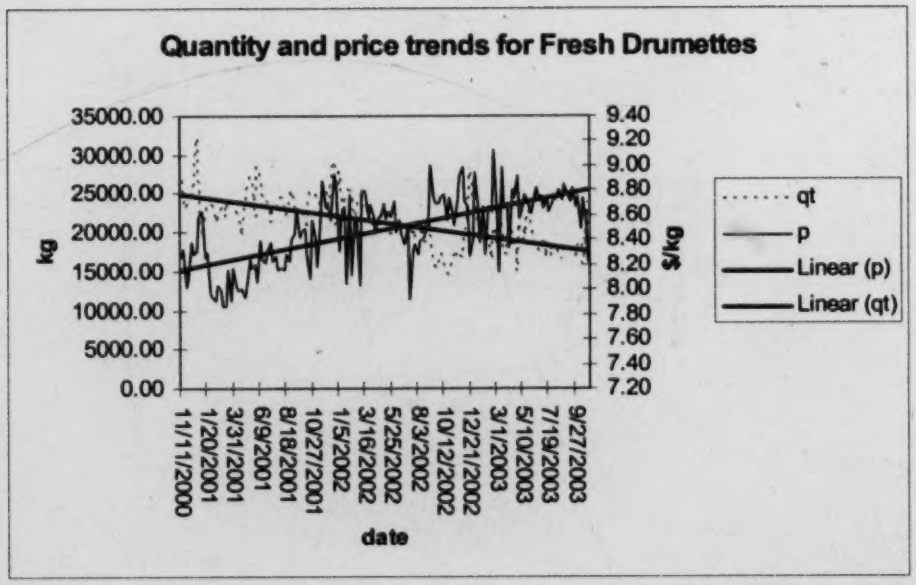


Source: ACNielsen 2003

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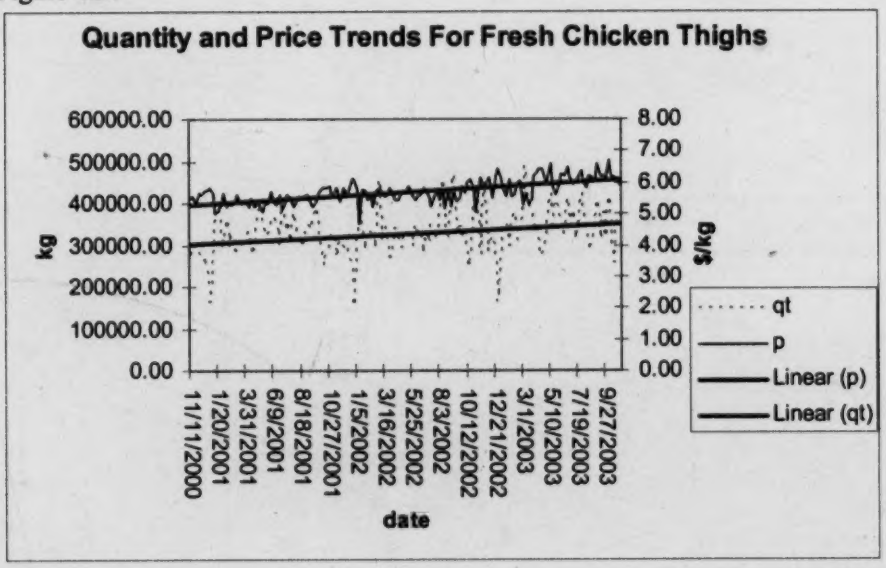


Source: ACNielsen 2003

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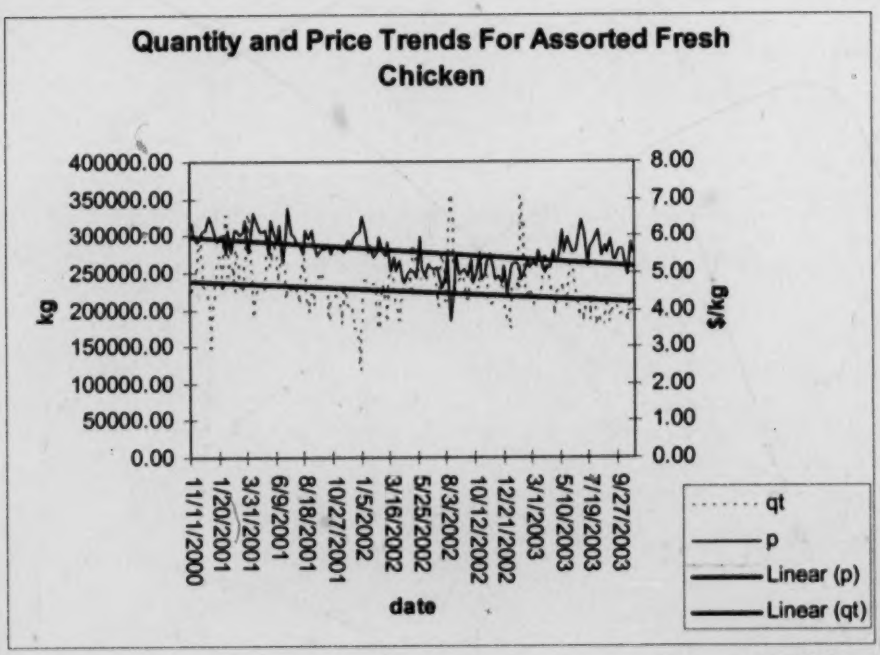


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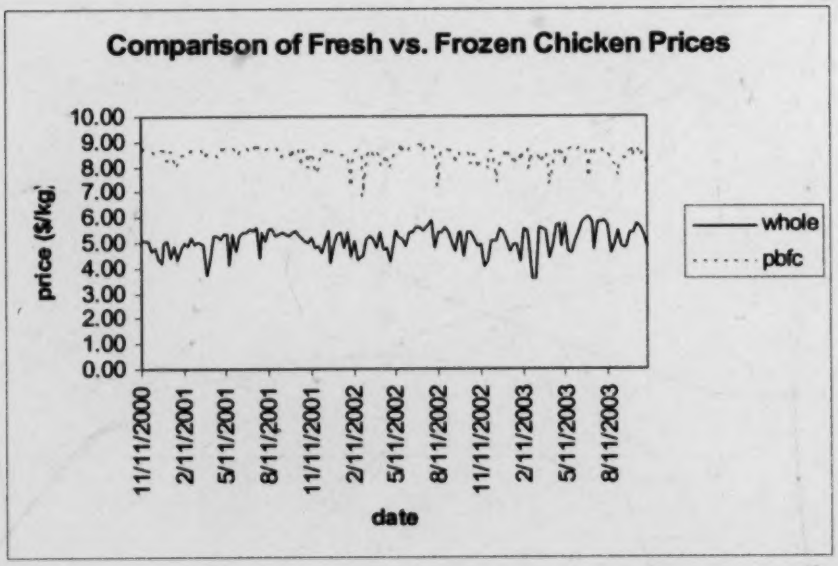


Source: ACNielsen 2003

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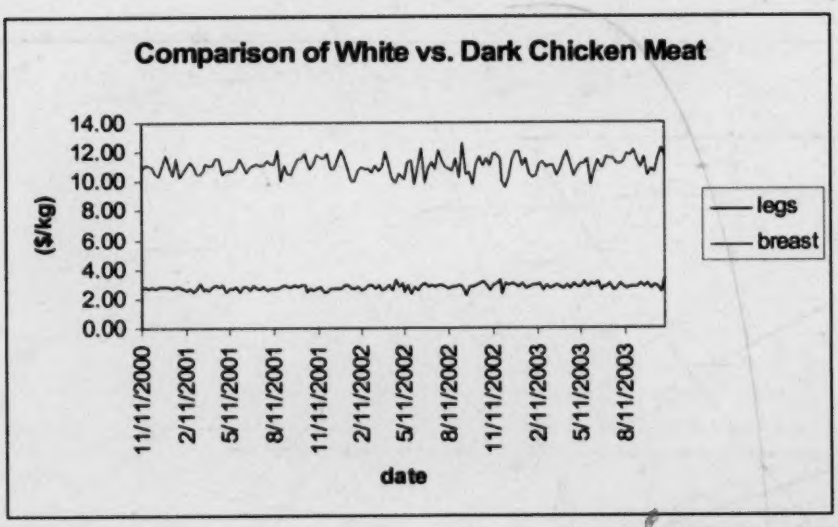
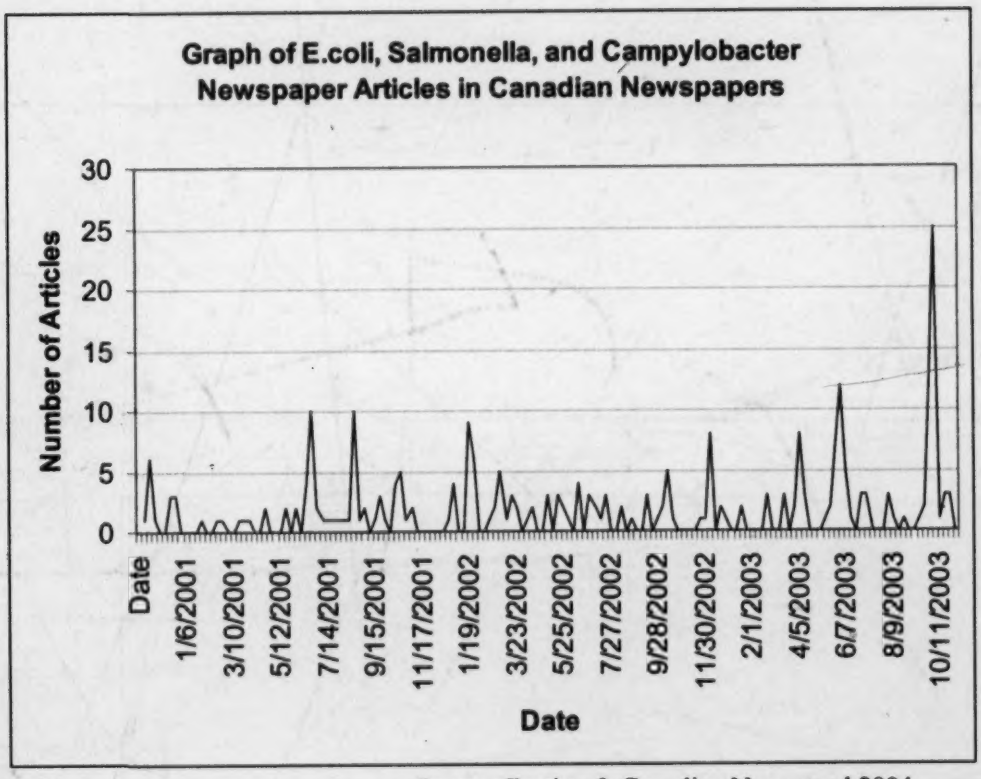



Source: ACNielsen 2003

Figure 4.31




Source: Factiva & Canadian Newsstand 2004

## Chapter 5 Results

### 5.1 Introduction

In chapter 4 an overview of the data used to estimate the AIDS model was provided, details of the results are provided in this chapter. Many important economic measurements will be presented such as substitution, expenditure, own, and cross price elasticities. Besides elasticities the model contains seasonal dummy variables, a food safety index, and other interesting variables which will be discussed and where model specification tests are provided to estimate their importance in explaining chicken consumption. Elasticities although important in their own right can be used to construct simulation models for illustrating how the market operates. A simulation model will be constructed highlighting different aspects of the domestic chicken market, where different types and cut of meat are sold. The model can be used to discover an improved marketing strategy for chicken products.

### 5.2 Estimation of Parameter Results for the AIDS Model

The model was estimated across the two stages simultaneously and only price of beef and the food safety index was not significant at the 10% confidence level or less (see Table 5.1). Time series data, especially of this frequency is often autocorrelated so the model was estimated with an autocorrelation correction built in. RHO1 and RHO2 are the autocorrelation coefficients for the first and second stage respectfully. The RHO1 autocorrelation parameter was not included in the final first stage of the estimation since its inclusion made some critical economic variables appear to be statistically

insignificant. RHO2 is positive and significant indicating that autocorrelation is present in the data and estimating without the correction could produce misleading results. The price of pork coefficient is significant and negative implying a complementary relationship since if the price of pork increases the consumption of chicken will decrease. The food safety index was not significant at the 10% confidence level at the first stage so as the incidence of E.coli, Salmonella and Campylobacter reporting increases the level of chicken consumption does not necessarily go down implying that people generally do not respond to these two food safety concerns at the macro level. The lagged total expenditure coefficient is positive, significant at the 10% level and between zero and one indicating habit persistence, if consumers purchased chicken last week they are likely to purchase it this week. All three of the seasonal dummy variables are significant and positive implying that the least amount of chicken is consumed in the fall and more is consumed in the other seasons relative to the fall. Both Thanksgiving and Christmas occur in the fall for the dataset and on both occasions big meals tend to be served with turkey being the bird of choice. In the time of the year where the most turkey is consumed less chicken might be purchased. The BSE dummy variable is significant at the first stage and has a positive sign indicating the weeks after the BSE outbreak spurred consumers to purchase more chicken which on the surface appears to be a logical result. Personal disposable income is also statistically significant and positive implying that as a persons income rises they will purchase more chicken.[1]

Table 5.2 shows the intercepts, time, and one period lagged quantity coefficients for the individual products. Some of the significant time coefficients had a positive sign which is expected since chicken consumption in general is increasing. However, others

[1] Statistical Significance or significant, refers to the 10% level unless stated otherwise in the text.

like breaded natural chicken, frozen parts, fresh drumettes, burger and assorted fresh chicken had a significantly negative time trend. Drumettes had an upward price trend over the time period of the data potentially explaining why the time trend was negative for this product. In the second stage of the model quantity was lagged one period to pick up any habit persistence in consumption. Breaded natural chicken, mixed frozen, and fresh drums had a negative coefficient implying that people are less likely to purchase these products within a week of their previous purchase. Much of the fresh chicken meat can be frozen so people may be purchasing a few weeks supply in advance possibly explaining why some of the coefficients were positive. Winglettes, kabobs and drumettes show a positive lagged quantity trend.

Table 5.3 shows the food safety index coefficients at the second stage. The food safety index captures the level of E.coli, Salmonella and Campylobacter media coverage in Canadian newspapers. The expectation is that it will reduce people's chicken consumption but at the product level it did not have a significant effect on any of the individual products. The articles on the whole did not reduce any of the individual product demands. Since no specific product recalls occurred over the time period of the data for chicken, many of the included articles focused on warning people to cook the meat properly. The non-threatening nature of the articles is probably the cause of the low affect at the second stage. E.coli, Salmonella, and Campylobacter can be killed easily with proper preparation techniques which people have been told about for a long time potentially explaining why the impact was weak.

Seasonal trends still exist in chicken product consumption as illustrated by Table 5.4. More of the parameters are significant for the spring and summer as compared to the

winter. Products that had a consistently significant seasonal trend in all three quarters include VBFC, FCB, PARTS, whole, brst, and assorted fresh. FCB is a frozen white meat product where more is consumed in the winter relative to the fall. After the fall consumers are probably tired of whole birds and look to flavored chicken breasts and BNC as a change that adds variety to the diet. Frozen PARTS experiences its highest consumption in the fall. On the fresh sub-group side whole birds are still mostly consumed in the fall quarter. A possible reason is that during Thanksgiving and Christmas some families may be looking for an alternative to turkey and ham, and chicken offers an alternative. Families today tend to be smaller and preparing a whole turkey is time consuming and tends to yield a lot of leftovers. Whole birds come in two types, fryers and roasters where roasters are larger. Around Thanksgiving and Christmas more roasters are sold because they substitute well with a small turkey.

Frozen wings are also seasonal with more sold in the fall. This is not surprising considering wings are a popular food served at informal get togethers and as the weather gets cooler outside less barbequing occurs. World Series baseball, NFL, Grey Cup, and hockey are all on T.V. during the fall lending occasions for people together to watch sports and snack on wings. Fresh breast meat is consumed more in the spring than in any other season. Frozen burgers both breaded and un-breaded are consumed significantly more in the spring and summer than in the fall. Fresh burgers are consumed more in the spring than in any other season. Frozen burgers both breaded and un-breaded are consumed significantly more in the spring and summer than the winter or fall due again to the increase in outdoor cooking activity. BNC shows an opposite trend to that of

burgers where more is consumed in the winter than the spring or summer, this trend holds for PBFC as well.

The outbreak of Bovine Spongiform Encephalopathy (BSE) was a major turning point in Canadian agricultural history, occurring after a few drought years, the discovery devastated the cattle industry. Consumers as well had to worry about developing CJV a terminal brain wasting disorder that had only previously been associated with BSE in European beef up to that point in time. From Table 5.5 the BSE dummy variable illustrates some interesting results, first that the outbreak has not caused consumers to purchase more chicken across the board for every chicken product. Some products had positive coefficients while others had negative. On an individual product basis PBFC and BNC went down and so did wings on both the frozen and fresh side. Products that experienced gain include fresh burger and nuggets and frozen un-breaded burgers . In the aftermath of the outbreak consumers appear to have been searching for products that can substitute well with beef. However, the time of the discovery also needs to be taken into account since mid May is the typical start of the Canadian BBQ season so consumers could have been drawn to these particular products for that reason alone. However, BBQ items were not the only ones to experience gain, fresh nuggets along with frozen FCB consumption was also higher after BSE. FCB is a commodity group that consists of highly marinated and processed breast meat, a product not suitable for the BBQ but would substitute nicely for a steak on the dinner plate. Recall that the chicken purchased at the retail store increased after BSE as indicated in the first stage of the demand system. Anecdotal evidence suggests that Canada was the only country where a BSE outbreak actually encouraged more beef consumption. Much of this beef was frozen and sold out

of the back of trucks in the summer and fall of 2003. Their also may be two classes of consumers in the marketplace that responded differently to the BSE outbreak. One group may have responded by purchasing more beef from unconventional sources and the other group may have responded by purchasing more chicken from the retail store specifically the products that substitute well with beef. Many of the products with increased demand are higher end white meat items. It may be that consumers at the retail store turned away from beef and more traditional breaded chicken products and wings for higher processed white meat. Before making any strong conclusions scanner data would need to be studied for both chicken and beef over a much longer period of time.

Table 5.6 presents the own and cross price effects for each of the twenty three products. Most of the own price effects are significant except for, legs, kabobs, nuggets, drumettes, thighs, and assorted fresh chicken. The fresh products that did not have significant own price effects are either very small or dark meat. Many of the cross price effects are significant as well, but the coefficient can be positive or negative in sign. If the cross price effect is positive that implies the goods may be substitutes and if the effect is negative the goods may be complements.

### 5.3 Weak Separability and Log-likelihood Ratio Tests

In order to determine if the model estimated is appropriate different variables are added to a base model which only contains prices and income. If the addition of another variable yields a higher log-likelihood it means that the model is better as a whole with the inclusion of that variable. However inclusion of the variables in the model still needs to be tested for significance using the log-likelihood ratio test. Table 5.7 contains the

results of these tests. The log-likelihood test statistic is compared to different critical chi-square values. If the log-likelihood test statistic is greater that the chi-square value for a certain level of significance then the model is significantly improved by the addition of the new variable. All of the variables included in the model except for the food safety index are significant at the 95% level. The test generally supports the model specification that was used in the analysis.

The results of the weak separability testes are given in Table 5.8. The weak separability can be tested by imposing restrictions on the model for each of the products and each of the sub categories of fresh and frozen as a whole. The results indicate that frozen chicken products are not weakly separable from fresh products as a whole and neither are any of their individual products. However, when the hypothesis was tested whether fresh chicken products are separable from frozen the test reveled that they are not as well. The weak separability tests generally support the notion that fresh and frozen chicken products can be estimated together in the same demand model, since they are both chicken.

## 5.4 Own and Cross Price Elasticities

The level of significance is quite high for this model estimation. Table 5.9 gives own and cross price elasticities at the second stage. Except for VBFC and BUGU all of the own price elasticities are significant at the 10% level. Just looking at the elasticities it is easy to see that frozen further processed chicken is more elastic then fresh items. For instance, the own price elasticity of demand for frozen un-flavored chicken breasts is

-4.95 which means that if the price of this commodity group goes up by 1% quantity demanded will fall by 4.95%. All of the own price elasticities at the second stage have the hypothesized negative sign. Fresh chicken items are more price inelastic which means that quantity demanded is less sensitive to price changes. Within the fresh sub-group the range of elasticities between white and dark products is dramatic. White meat is generally more price elastic then for certain dark meat cuts, breast meat is one of the most elastic of the fresh at -1.25 and fresh burger are the most inelastic part at -0.55. In chapter 4 whole birds were discussed and from the price trend it was hypothesized that consumers perceive them as dark meat. From the elasticity it looks like whole birds are perceived to be more like white meat then dark since the elasticity is even higher than that of breast meat. Consumers are sensitive to price changes for whole birds. The whole bird category also includes whole chickens that have been cut up and sold as 8 or 9 cut or birds that have been pre-seasoned. These modifications made to a whole bird could be causing the price elasticity to be higher than it would be if only unprocessed whole birds were taken into account. Even though most dark meat products tend to be more inelastic compared to white meat, drums have elasticities higher in magnitude then breast meat.

The own and cross price elasticities taken across both stages basically show the same patterns as at the second stage but the elasticities tend to get more elastic. Table 5.10 gives own and cross price elasticities across both stages. This is true for both the fresh products and the frozen ones. Many of the cross price elasticities are significant as well, if the cross price elasticity of demand is negative then the goods are gross complements if it is positive then they are gross substitutes. In measuring gross substitutes and complements, it is assumed that income is held constant and utility varies,

net substitutes by contrast hold utility constant and income is allowed to very. For example, looking at the fresh breast meat commodity only at the second stage PBFC, BNC, UFCB, WNGS, SC, PART are substitutes and BUGU, burg, wingt, and drumt are complements.

The cross price elasticities across both stages can differ significantly so it is important to look at the breast meat category again to see how the results change. Across both stages there are a greater number of statistically significant interactions between fresh breast meat and other commodity groups. It appears that except for whole birds where the relation is not statistically significant all of the other commodity groups are subsititutes for fresh breast meat.

Compensated own and cross price elasticities are also calculated. Table 5.11 gives compensated own and cross price elasticities. In terms of own price elasticities the pattern is almost the same as the uncompensated at the second stage. Since all compensated demand functions must be downward-sloping all of the own price elasticities have the expected negative sign. Again frozen products are more elastic then fresh items and dark meat is more inelastic then white meat. Taking a look at fresh breast meat we notice that most of the cross price elasticities are significant. Similar to the uncompensated elsticities at the second stage most of the significant relations are net substitutes. For instance the cross price elasticities of breast meat with respect to whole birds are 0.08 so if the price of whole birds increased by 1% quantity demanded of breast meat will increase by 0.08%. All of the significant elasticities are less than 1 implying that cross price effects are inelastic.

**5.5 Expenditure Elasticities**

The expenditure elasticity measures by what percentage quantity demanded changes for a 1% increase in expenditure on a particular commodity group. Table 5.12 gives the expenditure elasticities both at the second stage and across both stages. All of the expenditure elasticities taken at the second stage and across both stages have the expected positive sign except for fresh winglettes. If the expenditure elasticity is >1 then the goods in question are luxuries and if its <1 then the good is a necessity. Most of the expenditure elasticities are significant at the 10% level or better indicating that the amount people have to spend on chicken influences how much they purchase. In general the expenditure elasticities across both stages are more elastic then the ones at the second stage only. Since many of the frozen items are white meat and further processed they were expected to be luxuries with elasticities >1. PBFC, BNC, UFCB, PART, whole, drums, legs, thigh have expenditure elasticities >1. . Much of the product development has occurred in the frozen and further processed subgroups. Looking at the products individually many were just launched during the sample period while many were discontinued and others even started and finished within the sample period. Characterized by high turnover frozen chicken contains many experimental goods and companies try to see which products will catch on with consumers, examples would include products like "dinosaur shaped breaded chicken." Therefore, since many of the items are new consumers perhaps have not tried them or even know that they exist so the expenditure elasticities are showing them as necessities. Consumers are still discovering and experimenting with these products and have not fully incorporated them into their regular purchasing habits. Over time more of the frozen commodity groups expenditure

elasticities could go over one just like it has for BNC or they could stay inelastic like FCB. Many of the smaller commodity groups on the fresh side have inelastic expenditure elasticities, so perhaps the size of the frozen product category has influence on elasticity size. Whether the product is white or dark does not seem to effect the expenditure elasticity because many of the dark items like legs, drums, and thighs are greater then 1 at the second stage.

Whole birds also appears to be a luxury good with an expenditure elasticity of 1.84 implying that if a consumers expenditure increases by 1%, expenditure on whole birds goes up by more than 1%. Breast meat is expenditure inelastic so many consumers may already view it as a necessity perhaps because of health aspects.

**5.6 Substitution Elasticities**

Substitution elasticities are also calculated for the commodity groups. Table 5.13 gives the substitution elasticities. The substitution elasticity measures the percent change in the ratio of good y to x purchased in response to a percentage change in the price ratio (Binger and Hoffman, 1998). If the shape of the indifference curve is flat then consumers will substitute for y and reduce their consumption quite a bit for a given increase in the price of x. If the indifference curve is more bent then consumers will not reduce x and increase y very much for a given increase in the price of x. The two extreme cases are the Leontief and the linear indifference curves which have an elasticity of substitution of zero and infinity respectfully. The substitution elasticity can be useful in price competition experiments to see how much consumers are willing to substitute away from a good if its price is raised relative to other prices. All of the own substitution elasticities are negative as expected. The cross substitution elasticities are also given but to be consistent only

breast meat will be examined in detail, all other commodity groups can be analyzed in the same fashion. Most of the elasticities are significant and since none that are significant are negative it indicates people are willing to substitute towards breast meat if the price of other chicken products goes up. This is particularly true for other white meat products. For example if the price of frozen unflavored chicken breast were to increase by 1% consumers would substitute towards fresh breast meat by 6.1%. If the price of dark meat products such as thighs or drums increases people are much less willing to substitute to breast meat. This could be because dark meat is priced much lower compared to white meat and a large price increase would be needed before people would be encouraged to switch. This indicates that the substitutability of the two meat types is not very high. Or there could be different types of consumers in the market with strict preferences for either white or dark meat. People with strong preferences for one of the meat types are not willing to substitute easily. The smaller the substitution elasticity the less opportunity for trade off that exists and the two meats may be more like complements rather than substitutes. Another interesting commodity group is whole birds since it contains both types of meat. Overall the substitution elasticities are greater then one for every significant elasticity. Even for dark meat products like thigh and drums consumers are willing to switch to whole birds if individual product prices increase. With respect to white meat products on the frozen side which are less marinated, they are more substitutable with whole birds probably because they produce an un-marinated and un-seasoned breast just like the whole bird has.

## 5.7 Comparison of Elasticity Results with Other Papers

Many papers have been written both in Canada and the US on meat demand where the approaches differ but the calculation of elasticities is almost always done. This section will look at US and Canadian papers and compare their elasticity calculations to the ones in this thesis. Table 5.14 provides elasticity results from previous meat demand studies.

One of the first papers publishes that disaggregated chicken products was by Eales and Unnevehr (1988). They estimated an AIDS model on US meat demand and included a simple disaggregation of beef into hamburger and table cuts and pork was also included as a single meat. The two broad categories for chicken were "whole bird" and "parts and processed." Both own price elasticities were inelastic at -0.677 and -0.610 respectfully, and the expenditure elasticity for whole bird was -0.248 implying that whole birds are an inferior good. The results of my model show that the own price elasticities are more elastic, and expenditure elasticities are generally not negative. Since the products are still fairly aggregated in the previous paper and the data is annual, probably explaining the inelastic demand.

Chen and Veeman (1991) used an AIDS model to analyze beef, pork, chicken, and turkey demand using Canadian quarterly time series data. All of the own price elasticities were inelastic and the expenditure elasticities are all close to 1.00. This paper noted a structural change away from beef and towards chicken and that the increase in chicken's expenditure share is due to the structural change. At the disaggregated product level the expenditure elasticities have a much wider range from 0.21-1.79 when taken across both stages.

Many of the papers focus their attention on structural change in meat demand and the movement away from red meat in Canada (Reynold and Goddard, 1991, Xu and Veeman, 1995). In both papers similar results emerge where beef and pork become more inelastic after structural change and chicken becomes more elastic. Both papers only look at beef, pork, and chicken using similar data, generally the uncompensated elasticities are less than one.

Nayga and Capps (1994) estimate a Rotterdam model with weekly scanner data from a retail store in Houston. This is the first scanner paper analyzing disaggregated chicken by looking at breasts, parts, and other chicken. The own price elasticity for breasts is much more elastic then ours at -1.876 as compared to -1.25. The parts and other chicken categories are elastic probably because they contain frozen and further processed items. Although scanner data is used the scope of the study is limited since it is only from one store in one city, this could also affect the elasticities because the typical consumer that shops there is not representative of the general population as mentioned in the paper.

In 1995 Nayga estimated a QES using 1992 consumer expenditure survey data in the US. The only reported results are income elasticities for whole, chicken parts, and other poultry. All of the income elasticities are negative and less than one implying all chicken is inferior because if income increases consumption drops. Some authors are concerned with functional form issues for example Eales (1996) estimates a static, dynamic, and consistent ordinary and inverse differential AIDS using quarterly Canadian meat consumption data. The only items analyzed are beef, pork, and chicken but cross price elasticities are not reported. The more complex the functional form and the more types of forms being compared the less appealing it is to include disaggregated meat

products since the estimation becomes too cumbersome. The important result of this paper is that the inverse differential AIDS produces much more elastic own price elasticities than the ordinary AIDS. The ordinary AIDS has estimates in the same order as previous aggregated studies. The inverse differential AIDS seems to get around the problem of low elasticity estimates that often occur in aggregated studies.

Eales, Hyde, and Schrader (1998) estimate a Rotterdam model using quarterly USDA data from 1980-96. The reason this aggregated study was conducted was to look at meat demand starting from 1980 where it was believed that any structural change that occurred was over. All of the compensated own price elasticities are very inelastic including chicken at -0.14 implying that chicken is a necessity at the aggregate level.

The paper with the most detailed breakdown of individual chicken products was written by Parcell and Pierce (2000). They estimated an inverse demand model on USDA monthly time series data from (1988-97). Beef, pork and turkey are kept aggregated but chicken is broken down into boneless breast, ribbed breast, drums, legs, and wings. Both long and short run price flexibilities are reported and cross price flexibilities are not reported on the individual chicken products. In the short run demand is inelastic but in the long run the elasticities are more elastic. The long run flexibilities compare well to mine where boneless breast meat is more elastic then bone in breast meat and legs are inelastic at -0.78 as compared to -0.88 in my study. The long run flexibilities are also comparable -1.50 compared to -1.35 in this study for wings.

Having more disaggregated products allows for a better examination of the different demands that exist for the chicken products. The disaggregated results can be better used for marketing and certain types of policy analysis as compared to inelastic

aggregate elasticities. By focusing on one meat a commodity specific analysis can be done using the own and cross price elasticity results from the estimation.

### 5.8 Market Simulation Model

Even though the results just presented can provide a great deal of economic information more can be done with them. The parameters of the estimation can be used to construct market simulation experiments that can assist the industry in developing a marketing strategy by improving the quality of information in the system. The model is focused on the domestic market with different chicken products supplied and demanded and includes the farm, processing, and retail sectors. The objective of this model is to illustrate how the farm supply, producer surplus, processor revenue and the domestic quantities are affected by a change in the pricing strategy for different types of chicken products as well as potential impacts of marketing strategies in the related meats industry. One of the main objectives of the simulation model is to discover the dynamic relationships that exist between white and dark meat.

The assorted (ast) category also serves another vitally important role with respect to live chickens slaughtered. It makes up the difference for all of the products that comprise a whole bird so that the product yields come off in fixed proportions. All of the yields of each product are derived from a whole eviscerated chicken. Since many of the frozen products are white meat their proportion is subtracted from the breast meat and other dark meat like burger is derived from either, legs, or the assorted category of fresh dark meat.

The synthetic simulation model contains a wide array of data from 2001 to be able to reproduce a static representation of the market at a particular point in time. Figure 5.2 illustrates the simplified structure of the simulation model for a two product white meat/dark meat case. Data on retail quantities, retail price, farm supply and live birds, farm marginal cost, and quota value as well as processor supply and export levels are given starting values for the simulation (1). The purpose of the first simulation is to determine a base case to make sure the model is working properly since it has to yield approximately the same information that was put into it. Since the chicken industry is supply managed, farmers always get a constant price for the bird in this case $1.45/kg live. The farm price is made up of two components; the first is marginal cost which is subject to supply conditions. The other component is the average static quota value which makes up the difference between marginal cost and the regulated farm price, processors pay the farm price. Although processors are not forced to buy a strict quantity they are required to pay a set price. Therefore, the quota value can also gain and lose value depending on the strength of the market. Farm marginal cost and farm supply of live birds were obtained from the CFC (2002). Retail prices come from the Nielsen data and all of the other data is generated internally form the live birds. It is assumed that every bird slaughtered yields 1.53 kg of eviscerated meat (CFC Chicken Data Handbook, 2002).

There are two main levels illustrated in the model the first is the processor level and the other is the retail level. Market levels are linked together since Retail Demand=Processor Supply for a particular product and Processor demand for Live Birds=Farm Supply for live birds. Farm supply and processor demand elasticities are

taken from Fulton and Tang's (1999) analysis of the Canadian chicken industry to make the processor demand and farm supply equations. The basic measure of producer welfare for the industry is producer surplus which is the area above the supply curve up to the price level that represents revenue received from selling birds above the price that they would have been willing to sell them at. The amount of producer surplus is determined by the shape of the supply and demand curve and the more producer surplus that farmers can capture the better off they will be. Initially the base model has producer surplus set at $518,971,000. The four additional simulations that are conducted are simulation (2) raising the price of pork by 10% simulation(3) lowering the price of fresh white chicken [brst,wings, wingt,drumt kabobs] by 1% simulation(4) lowering the price of frozen chicken products [PBFC, VBFC, BNC, FCB, UFCB, WNGS, SC, BUGU, BUGB, PART, MIX] by 1% simulation(5) raising the price of fresh dark meat [whole, drum, burg, legs, nugg, thigh, ast] by 1%. All simulation results are presented as the percent change from the base case and as such can be negative to illustrate a reduction in that variable or positive to show an increase. The synthetic simulation model was implemented by taking the results of the estimation and placing then in TSP. The first part of the simulation is identical to the estimation and the second part follows the structure that was described above. The simulation is deterministic and does not take into account any error that might be in the parameters or variables. Results of the one year simulation are given in Table 5.15. The main variables that will be examined are, quantity on the domestic retail market (Qui), retail price (Pi) farm supply (FS)which is number of birds sold, producer surplus (PS), marginal cost (MC), quota value (QV), processor revenue (PRV) and total expenditure (LTEXP) on chicken. When the price of

pork is increased by 10% which could be the result of new product development or marketing strategies by the pork industry is illustrated by Sim(2). In terms of domestic quantity all the product categories except for fresh burger, winglettes, kabobs, and un-breaded frozen burger experience decreasing quantities supplied to the domestic retail market. Frozen unflavored chicken breasts experience the deepest cut in domestic quantity at 8.87%. At the processor level slaughter goes up by 0.85%. Producer surplus correspondingly increases by 0.19% and quota value drops by 4.15% to keep farm price stable. Processor revenue drops by 4.9% from the pork price increase. With a 10% increase in the price of pork the total expenditure on chicken goes down only by 0.28%, this implies that actions taken with respect to the pricing of pork do not have large effects on the chicken market this could be due to the supply management system or perhaps consumers do not see pork and chicken as close substitutes but more as complements between the two meats.

In Sim(3) the value of fresh white meat is shocked so breasts, wings, drummettes, winglettes and fresh kabob values are lowered by 1%. The lowering of the fresh white meat value increases domestic quantity sold by 1.51% for breast, 1.42% for wings, 0.45% for winglettes, and 1.17% for drummettes but the quantity of fresh kabobs sold drops by 0.89% the quantities of most other chicken categories increase by less than 1% for a 1% drop in fresh white meat value except for whole bird which increases 1.33%. Some products like frozen wings, frozen unflavored chicken breasts stuffed chicken and frozen parts goes down 0.75%, 1.40%, 0.52% , and 0.01% respectfully. Farm supply or slaughter drops by 0.67% and producer surplus drops by only 0.16% of a reduced white

meat price. Farmer's quota value increases by 3.26% and the total expenditure on chicken increase by 0.03%. Processor revenue increases by 0.71%.

Since the characteristics of most frozen chicken products is different from fresh it made sense to see what effect lowering the value of all frozen products by 1% would have on the market, Sim(4) shows these results. Except for un-breaded frozen burger all retail quantities increase on the frozen side. However, many of the fresh products experience decreases in quantity sold breasts, drums, wings, kabobs, fresh burger, wing parts, as well as nuggets and thighs experience reduction. The amount of birds supplied for slaughter decrease 0.29% but producer surplus drops by only 0.10%. Out of all the price simulations lowering the value of frozen chicken increases total expenditure the least at 0.01%. The marginal cost of what processors pay drops by 0.33% but quota value rises 1.41% to keep farm price constant. Processor revenue increases by 0.31%.

The final chicken meat simulation, Sim(5) raises the value of fresh dark meat by 1%. This simulation includes whole birds as a dark meat product. The quantity sold on the domestic market decreases for every product category except for frozen wings, fresh wings, winglettes, and drummettes when dark meat values are lowered. When the value of dark meat is raised farm supply and producer surplus go up by 0.66% and 0.15% respectively. The total expenditure on chicken decreases but not by very much only 0.03%, and the quota values drops 3.21%. Processor revenue goes down by 0.64%.

## 5.9 Summary

This chapter presented the results of the demand analysis for 23 major chicken products sold at Canadian retail stores. The chapter also presented a simulation model with selected products to illustrate the importance of the results for use in policy analysis.

The results provide the industry with a greater level of detail than ever provided before on the nature of consumer demand for chicken. Factors other than price and expenditure affect consumers purchasing decisions but factors such as BSE and seasonality effect chicken products differently and it is important to notice subtle differences in developing marketing strategies or other such initiatives. The results help the entire industry to be better informed in decisions they make. The next chapter will summarize the thesis and provide further discussion on the results and possible areas of further research.

Table 5.1 Estimates of First Stage Parameters and RHO2 of the AIDS Model

| Coefficient | Description of Variable | Estiamte |
|---|---|---|
| C1 | constant | 1.29683 |
| RHO2 | auto-correlation coefficient | 0.124195*** |
| D1 | PSTAR | -0.867921*** |
| U1 | price of pork | -0.165241* |
| U2 | price of beef | -0.061952 |
| K1 | food safety index | 9.72E-04 |
| G1 | personal disposable income | 1.65201*** |
| J1 | total expenditure | 0.10355*** |
| Q1 | winter seasonal dummy | 0.075055*** |
| Q2 | spring seasonal dummy | 0.099441*** |
| Q3 | summer seasonal dummy | 0.075325*** |
| F1 | BSE dummy variable | 0.049408** |

*** => 99% confidence level
** => 95% confidence level
* => 90% confidence level

Table 5.2 Intercepts, Time Trend, and Lagged Quantity Estimates for the Disaggregated Products.

| | | Time | | Lagged | |
|---|---|---|---|---|---|
| Intercepts | | Trend | | Quantity | |
| A1 | -0.294268*** | X1 | -3.32E-05* | J11 | -7.88E-09 |
| A2 | 6.89E-03 | X2 | 2.61E-06 | J21 | 5.06E-09 |
| A3 | -0.141557*** | X3 | -4.49E-05*** | J31 | -4.36E-08*** |
| A4 | 0.070856*** | X4 | -2.64E-05*** | J41 | -3.94E-09 |
| A5 | -0.203485 | X5 | -1.27E-04*** | J51 | -1.91E-09 |
| A6 | 0.758298*** | X6 | 1.13E-04*** | J61 | -9.18E-09 |
| A7 | 0.012613 | X7 | -9.55E-06 | J71 | -2.79E-09 |
| A8 | 0.072193*** | X8 | 7.11E-06* | J81 | 3.69E-08*** |
| A9 | 9.81E-03 | X9 | 1.63E-06 | J91 | 9.89E-09 |
| A10 | -5.42E-03* | X10 | -1.20E-05*** | J101 | 1.29E-09 |
| A11 | 0.039512 | X11 | 3.68E-05*** | J111 | -3.63E-08*** |
| A12 | -1.81904*** | X12 | -8.23E-05* | J121 | 2.18E-09 |
| A13 | 2.26758*** | X13 | 2.07E-04*** | J131 | 1.80E-09 |
| A14 | -0.110237** | X14 | 2.39E-05 | J141 | -7.93E-09*** |
| A15 | 0.30432*** | X15 | 5.46E-05*** | J151 | 2.14E-08*** |
| A16 | 8.62E-03*** | X16 | -8.63E-07* | J161 | 4.96E-09 |
| A17 | -0.268662*** | X17 | -4.08E-05 | J171 | 3.19E-09 |
| A18 | 0.028076*** | X18 | 1.34E-06 | J181 | 4.88E-08*** |
| A19 | 0.116083*** | X19 | -2.74E-06 | J191 | 6.60E-08*** |
| A20 | 9.69E-04 | X20 | -2.23E-07 | J201 | -3.87E-09 |
| A21 | 0.100812*** | X21 | -8.41E-06** | J211 | 7.89E-08*** |
| A22 | -4.41E-03 | X22 | 4.90E-05** | J221 | -7.22E-09** |
| A23 | 0.05065 | X23 | -1.09E-04*** | J231 | -1.56E-07*** |

*** => 99% confidence level

** => 95% confidence level

* => 90% confidence level

Table 5.3 Food Safety For The Disaggregated Products.

| Food Safety | |
|---|---|
| K11 | -1.18E-05 |
| K21 | 1.03E-05 |
| K31 | -6.59E-05 |
| K41 | 3.52E-05 |
| K51 | 3.34E-04 |
| K61 | 1.08E-04 |
| K71 | -5.83E-05 |
| K81 | 2.26E-05 |
| K91 | 1.70E-05 |
| K101 | 2.18E-06 |
| K111 | -6.02E-05 |
| K121 | -5.91E-05 |
| K131 | -4.02E-04 |
| K141 | -1.65E-05 |
| K151 | 5.10E-06 |
| K161 | 2.14E-06 |
| K171 | 1.20E-04 |
| K181 | 3.66E-06 |
| K191 | 8.75E-06 |
| K201 | 6.86E-07 |
| K211 | 2.41E-05 |
| K221 | -4.64E-05 |
| K231 | 2.73E-05 |

*** => 99% confidence level
** => 95% confidence level
* => 90% confidence level

Table 5.4 Seasonality Trends for the Disaggregated Products.

| Winter | | Spring | | Summer | |
|---|---|---|---|---|---|
| Q11 | -1.04E-03 | Q12 | -0.011896*** | Q13 | -0.010715*** |
| Q21 | 5.18E-04*** | Q22 | -4.74E-04*** | Q23 | -3.43E-04* |
| Q31 | -2.56E-04 | Q32 | -2.99E-03*** | Q33 | -3.76E-03*** |
| Q41 | 1.30E-03*** | Q42 | 3.52E-03*** | Q43 | 3.64E-03*** |
| Q51 | 8.22E-04 | Q52 | 3.65E-03 | Q53 | 5.29E-03 |
| Q61 | 2.87E-03 | Q62 | -5.30E-03*** | Q63 | -7.92E-03*** |
| Q71 | -3.46E-04 | Q72 | -1.72E-03*** | Q73 | -2.48E-03*** |
| Q81 | 3.60E-04 | Q82 | 1.95E-03*** | Q83 | 1.50E-03*** |
| Q91 | 6.11E-04 | Q92 | 2.44E-03*** | Q93 | 2.20E-03*** |
| Q101 | -2.19E-04*** | Q102 | -3.13E-04*** | Q103 | -2.48E-04*** |
| Q111 | 1.36E-03 | Q112 | 5.22E-03*** | Q113 | 5.04E-03*** |
| Q121 | -0.021854*** | Q122 | -0.028674*** | Q123 | -0.019757*** |
| Q131 | 0.020763*** | Q132 | 0.028934*** | Q133 | 0.022498*** |
| Q141 | -1.31E-03 | Q142 | 1.04E-04 | Q143 | 1.42E-03 |
| Q151 | -5.31E-04 | Q152 | -1.22E-03 | Q153 | -1.24E-03 |
| Q161 | 1.81E-05 | Q162 | 5.44E-05** | Q163 | 3.41E-05 |
| Q171 | -3.04E-03 | Q172 | -1.60E-03 | Q173 | -3.28E-03 |
| Q181 | -1.39E-05 | Q182 | 5.91E-05 | Q183 | -3.36E-06 |
| Q191 | 1.02E-03 | Q192 | 6.92E-03*** | Q193 | 6.17E-03*** |
| Q201 | 1.23E-05 | Q202 | -1.47E-05 | Q203 | -6.14E-05*** |
| Q211 | -6.63E-05 | Q212 | -6.66E-05 | Q213 | -3.36E-04 |
| Q221 | -6.26E-04 | Q222 | 4.10E-04 | Q223 | 2.66E-03 |
| Q231 | 0.999653*** | Q232 | 1.00103*** | Q233 | 0.999683*** |

*** => 99% confidence level

** => 95% confidence level

* => 90% confidence level

Table 5.5 The Effect of BSE on Disaggregated Product Consumption.

| BSE | |
|---|---|
| F11 | -7.07E-03*** |
| F21 | 2.57E-06 |
| F31 | -2.17E-03*** |
| F41 | 2.03E-03*** |
| F51 | 6.58E-03 |
| F61 | -6.79E-03** |
| F71 | -1.06E-04 |
| F81 | 5.44E-04* |
| J91 | 9.89E-09 |
| F101 | -1.79E-04 |
| F111 | 1.38E-03 |
| F121 | -6.89E-03 |
| F131 | 5.16E-03 |
| F141 | 1.70E-03 |
| F151 | -4.03E-03*** |
| F161 | 6.18E-04*** |
| F171 | 2.99E-03 |
| F181 | 2.67E-04*** |
| F191 | 3.06E-03*** |
| F201 | 1.05E-04*** |
| F211 | 9.55E-05 |
| F221 | 2.08E-03 |
| F231 | 3.54E-04 |

*** => 99% confidence level
** => 95% confidence level
* => 90% confidence level

Table 5.6 Own and Cross Price Effects from the AIDS Model Estimation.

| | u1 | u2 | u3 | u4 | u5 | u6 | u7 | u8 | u9 | u10 | u11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| u1 | -0.097462*** | | | | | | | | | | |
| u2 | 1.38E-03 | 5.26E-03*** | | | | | | | | | |
| u3 | 5.47E-03** | -2.82E-03*** | -0.046381*** | | | | | | | | |
| u4 | 3.39E-03** | 1.31E-04 | 9.29E-04 | -8.76E-03*** | | | | | | | |
| u5 | 3.92E-03 | -9.02E-04 | 2.25E-03 | 5.65E-04 | -0.121159*** | | | | | | |
| u6 | 3.11E-03 | -2.02E-03* | 3.07E-03 | 5.99E-03*** | 0.026732*** | -0.063511*** | | | | | |
| u7 | -4.95E-03** | -7.75E-04 | 1.57E-03 | -3.02E-04 | -3.46E-04 | -1.84E-03 | -4.13E-03*** | | | | |
| u8 | 2.48E-03** | -2.04E-03*** | 2.17E-04 | 2.21E-04 | 1.39E-04 | 2.39E-03** | 7.79E-04 | 3.92E-03*** | | | |
| u9 | -6.78E-03*** | 2.64E-04 | 7.99E-03*** | 1.06E-03 | 5.99E-04 | 2.08E-03 | 5.54E-03*** | 3.06E-04 | -0.014502*** | | |
| u10 | -4.80E-04 | 9.68E-05 | 2.85E-04 | 8.99E-07 | 3.95E-04 | 7.22E-04 | -1.58E-04 | 1.30E-04 | 3.25E-04 | -3.44E-03*** | |
| u11 | 6.35E-03*** | -7.47E-05 | 2.41E-03*** | -1.92E-06 | -4.31E-03 | 1.92E-03 | 8.88E-04 | -4.17E-04 | 1.30E-04 | 2.88E-04* | -0.011813*** |
| u12 | 0.013509*** | 1.58E-04 | 4.87E-03*** | 1.64E-03 | 0.025948*** | 0.016313** | -1.54E-03 | -7.65E-04 | 5.15E-03*** | -6.81E-05 | 4.80E-03* |
| u13 | 0.031413*** | -1.35E-05 | 8.16E-03*** | 2.01E-04 | 0.06004*** | 0.019828* | 3.77E-03* | -3.35E-03*** | 3.54E-03 | 7.57E-04* | 3.85E-03 |
| u14 | 9.99E-03*** | -1.39E-03 | 2.98E-04 | -1.53E-04 | -3.50E-03 | 0.013227*** | -1.12E-03 | -1.80E-03* | -1.27E-03 | 7.19E-04 | -1.54E-03 |
| u15 | 1.44E-03 | -3.10E-04 | -1.55E-04 | -1.10E-03 | 8.52E-03*** | 4.86E-03 | 1.81E-04 | -1.10E-03 | -2.21E-03 | 1.61E-04 | -1.13E-03 |
| u16 | 1.47E-04 | 5.62E-05 | 1.04E-04 | -1.49E-06 | -9.00E-05 | 9.79E-05 | 1.36E-04* | 1.35E-04 | -9.83E-06 | 5.42E-06 | -8.97E-05** |
| u17 | -1.11E-03 | 7.15E-04 | 7.19E-04 | 1.10E-04 | 4.77E-03 | -1.66E-03 | 1.93E-04 | -7.47E-04 | -1.30E-03 | 4.82E-05 | 5.41E-03* |
| u18 | -7.53E-05 | -1.52E-04 | 1.05E-04 | 7.32E-05 | 1.73E-04 | 7.70E-04*** | -4.13E-06 | -3.14E-05 | 1.96E-04 | 1.94E-04** | -1.26E-04* |
| u19 | 8.45E-03*** | 8.15E-05 | 9.17E-04 | -7.00E-04 | 1.84E-03 | 3.23E-03 | 2.90E-03** | -8.87E-04 | 3.44E-04 | 4.76E-04* | -2.33E-03* |
| u20 | 2.60E-05 | 2.66E-04*** | -6.42E-06 | 1.57E-05 | -1.06E-06 | -2.03E-04* | -1.82E-04*** | 1.58E-04** | 6.47E-05 | -2.76E-05 | 3.02E-05 |
| u21 | -1.64E-03* | 1.04E-03 | 3.53E-04 | 7.12E-04*** | 1.76E-03*** | 1.09E-03 | 4.60E-04 | 3.53E-04 | 1.31E-03* | 2.68E-04 | -1.95E-04 |
| u22 | 0.011474*** | 5.57E-04 | 6.18E-03*** | -1.43E-03 | -6.93E-03 | 0.012378** | -2.80E-03 | -3.33E-03*** | 1.31E-04 | -6.69E-04 | -1.87E-03 |
| u23 | 9.96E-03*** | 4.88E-04 | 3.47E-03** | -2.60E-03** | -3.96E-04 | -0.01595*** | 1.72E-03 | 3.23E-03 | -2.98E-03* | -3.11E-05 | -2.18E-03 |

Table 5.6 cont. Own and Cross Price Effects from the AIDS Model Estimation.

| | u12 | u13 | u14 | u15 | u16 | u17 | u18 | u19 | u20 | u21 | u22 | u23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| u1 | | | | | | | | | | | | |
| u2 | | | | | | | | | | | | |
| u3 | | | | | | | | | | | | |
| u4 | | | | | | | | | | | | |
| u5 | | | | | | | | | | | | |
| u6 | | | | | | | | | | | | |
| u7 | | | | | | | | | | | | |
| u8 | | | | | | | | | | | | |
| u9 | | | | | | | | | | | | |
| u10 | | | | | | | | | | | | |
| u11 | | | | | | | | | | | | |
| u12 | -0.061454*** | | | | | | | | | | | |
| u13 | 0.013748 | -0.14297*** | | | | | | | | | | |
| u14 | 5.12E-03 | -1.18E-03 | -0.021252*** | | | | | | | | | |
| u15 | -5.87E-03** | 9.95E-04 | 2.61E-03 | -0.014252*** | | | | | | | | |
| u16 | -1.74E-04** | -5.52E-04*** | -7.20E-05 | -8.57E-05 | 2.98E-04*** | | | | | | | |
| u17 | 4.33E-03 | 0.013845 | -0.012462*** | 4.44E-03 | -2.04E-04*** | 7.65E-03 | | | | | | |
| u18 | -6.50E-04*** | -6.50E-04*** | 6.17E-04** | 1.57E-05 | 2.82E-04*** | -9.08E-05 | 5.14E-04** | | | | | |
| u19 | 1.21E-03 | -1.74E-03 | -1.50E-03 | -2.10E-03 | 1.56E-04** | -2.31E-03 | 4.11E-05 | 8.08E-04 | | | | |
| u20 | 1.59E-05 | -1.54E-05 | 3.14E-05 | -2.66E-04*** | 4.34E-05** | -3.05E-05 | 2.33E-05 | -1.23E-04** | -2.01E-05 | | | |
| u21 | -2.83E-03*** | -2.09E-03** | 3.13E-03*** | -4.79E-04 | -1.18E-04 | -8.45E-04 | -2.91E-04 | -1.91E-04 | -3.91E-06 | 3.73E-05 | | |
| u22 | 2.44E-03 | -0.010885 | 0.010708** | 5.71E-03** | -9.63E-05 | -0.019344*** | -7.82E-04*** | -1.41E-03 | 8.70E-05 | -1.43E-03 | -1.07E-04 | |
| u23 | 6.74E-03* | 3.28E-03 | 7.09E-04 | 1.26E-04 | -3.20E-05 | -2.12E-03 | -1.51E-04 | -7.17E-03*** | 1.16E-04* | -4.02E-04 | 1.41E-03 | 2.75E-03 |

Table 5.7 Log-Likelihood Ratios for Model Robustness.

| Variable | n | Log-likelihood | LL-Test Stat | Chi-Square |
|---|---|---|---|---|
| Significance | | | | 95% |
| Base | | 17811.1 | | |
| Food Safety | 23 | 17820 | 17.8 | 35.17 |
| Time | 23 | 17914 | 188 | 35.17 |
| BSE | 23 | 18024 | 220 | 35.17 |
| Lagged Quantity | 23 | 18053.7 | 59.4 | 35.17 |
| Seasonality | 69 | 18185.9 | 264.4 | 67.50 |

Table 5.8 Weak Separability Test Results.

| Hypothesis | DF | (0.05) Critical Chi-square Value | AIDS Test Statistic |
|---|---|---|---|
| **Frozen Chicken Products Separable From:** | | | |
| FRESH | 132 | 63.17 | 6955.21 |
| whole | 11 | 17.28 | 152.28 |
| breast | 11 | 17.28 | 132.07 |
| drums | 11 | 17.28 | 130.29 |
| wings | 11 | 17.28 | 70.23 |
| burger | 11 | 17.28 | 120.35 |
| legs | 11 | 17.28 | 113.91 |
| winglettes | 11 | 17.28 | 131.63 |
| kabobs | 11 | 17.28 | 21.06 |
| nuggets | 11 | 17.28 | 91.87 |
| drumettes | 11 | 17.28 | 56.22 |
| thigh | 11 | 17.28 | 99.01 |
| assorted | 11 | 17.28 | 187.48 |
| **Fresh Chicken Products Separable From:** | | | |
| FROZEN | 110 | 63.17 | 323.39 |
| PBFC | 10 | 15.99 | 166.53 |
| VBFC | 10 | 15.99 | 124.86 |
| BNC | 10 | 15.99 | 137.59 |
| FCB | 10 | 15.99 | 43.9 |
| UFCB | 10 | 15.99 | 173.57 |
| WNGS | 10 | 15.99 | 178.89 |
| SC | 10 | 15.99 | 26.44 |
| BUGU | 10 | 15.99 | 74.9 |
| BUGB | 10 | 15.99 | 71.75 |
| PART | 10 | 15.99 | 33.48 |
| MIX | 10 | 15.99 | 58.82 |

Table 5.9 Own and Cross Price Elasticities at the Second Stage.

| | e1 | e2 | e3 | e4 | e5 | e6 | e7 | e8 | e9 | e10 | e11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| e1 | -2.80011*** | 9.72E-03 | 0.235951* | 0.239462 | 0.084282 | 0.034066 | -0.904153*** | 0.245789 | -0.709722*** | -1.52029*** | 0.380307** |
| e2 | 0.02517 | -0.065035 | -0.160734*** | 0.015104 | -0.029379 | -0.038639** | -0.111785 | -0.434886*** | 0.022975 | 0.080494 | -5.74E-03 |
| e3 | 0.09583** | -0.539505*** | -3.65341*** | 0.083178 | 0.066319 | 0.05467 | 0.195753 | 1.00E-03 | 0.681027*** | 0.06132 | 0.166257** |
| e4 | 0.062431** | 0.029543 | 0.054873 | -2.01219*** | 0.019521 | 0.115365*** | -0.038485 | 0.054468 | 0.096212* | 0.030042 | 2.49E-03 |
| e5 | 0.062081 | -0.251223** | 0.099042 | 6.30E-03 | -4.95935*** | 0.501781*** | -0.123318 | -0.079238 | 7.72E-03 | -0.097067 | -0.365348 |
| e6 | 0.100714 | 0.071348 | 0.312534** | 0.976244*** | 0.948633*** | -2.16908*** | 0.083408 | 1.02451*** | 0.39395* | 2.64146*** | 0.328519 |
| e7 | -0.09019** | -0.137511 | 0.089613 | -0.034811 | -0.011181 | -0.035169 | -1.5939*** | 0.166494 | 0.485563*** | -0.13136 | 0.067438 |
| e8 | 0.045575** | -0.35917*** | 0.01348 | 0.027944 | 5.18E-03 | 0.046081** | 0.115067 | -0.159585 | 0.028531 | 0.126259 | -0.030051 |
| e9 | -0.123374*** | 0.04821 | 0.455461*** | 0.124348* | 0.019736 | 0.039953 | 0.799297*** | 0.06678 | -2.26902*** | 0.279588 | 0.01039 |
| e10 | -8.76E-03 | 0.017108 | 0.016185 | 3.04E-05 | 0.012845 | 0.013796 | -0.022886 | 0.027583 | 0.028391 | -3.89134*** | 0.021755* |
| e11 | 0.116131*** | -9.03E-03 | 0.138447*** | 2.55E-03 | -0.139584 | 0.037172 | 0.131349 | -0.083748 | 0.013445 | 0.26222* | -1.89281*** |
| e12 | -0.110634 | -3.45493*** | -0.837917*** | -2.0822*** | 0.207209 | -0.686874*** | -3.04146*** | -4.33612*** | -1.26392*** | -16.5253*** | -1.11918*** |
| e13 | 1.42495*** | 8.31929*** | 3.12943*** | 5.45252*** | 3.47635*** | 1.27478*** | 7.27938*** | 9.25718*** | 4.40606*** | 39.9862*** | 3.8352*** |
| e14 | 0.174366*** | -0.321093* | -6.78E-03 | -0.066157 | -0.12762 | 0.245128*** | -0.221082 | -0.471644** | -0.147457 | 0.253586 | -0.14836 |
| e15 | 0.038909 | 0.069325 | 0.030981 | -0.045975 | 0.299894*** | 0.106405 | 0.126763 | -0.085166 | -0.132288 | 0.723861*** | -0.032668 |
| e16 | 2.69E-03 | 0.010066 | 5.92E-03 | -1.33E-04 | -2.92E-03 | 1.88E-03 | 0.019621* | 0.028942 | -8.30E-04 | 4.86E-03 | -6.76E-03** |
| e17 | -0.040151 | -0.066685 | -0.021112 | -0.113628 | 0.11972 | -0.052645 | -0.129058 | -0.391441** | -0.209537 | -0.875773*** | 0.327223 |
| e18 | -1.33E-03 | -0.026705 | 6.11E-03 | 8.76E-03 | 5.72E-03 | 0.014785*** | -2.60E-04 | -6.20E-03 | 0.01734 | 0.165081** | -9.39E-03 |
| e19 | 0.154846*** | 0.023585 | 0.055117 | -0.075268 | 0.061511 | 0.062795 | 0.424909** | -0.178234 | 0.03462 | 0.442897** | -0.1724* |
| e20 | 4.73E-04 | 0.047342*** | -3.66E-04 | 1.82E-03 | -3.47E-05 | -3.89E-03* | -0.026151*** | 0.033645** | 5.66E-03 | -0.023233 | 2.29E-03 |
| e21 | -0.029079* | 0.192423 | 0.022379 | 0.087163*** | 0.058405*** | 0.02167 | 0.071863 | 0.083689 | 0.118068* | 0.258911 | -0.01179 |
| e22 | 0.204931*** | 0.058626 | 0.339147*** | -0.192408 | -0.23284 | 0.232527** | -0.435717* | -0.757584*** | -8.37E-03 | -0.753628 | -0.158957 |
| e23 | 0.181165*** | 0.084328 | 0.196536** | -0.303653** | -0.013343 | -0.305495*** | 0.246169 | 0.685452 | -0.260164* | -0.038126 | -0.165809 |

Table 5.9 cont. Own and Cross Price Elasticities at the Second Stage.

| | e12 | e13 | e14 | e15 | e16 | e17 | e18 | e19 | e20 | e21 | e22 | e23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| e1 | 0.0799*** | 0.079358*** | 0.182591*** | 2.75E-03 | -1.78952*** | -0.046202 | -1.08837*** | 1.13791*** | -2.21306*** | -0.472976*** | 0.15983** | 0.199888** |
| e2 | 1.02E-03 | -3.86E-05 | -0.02929 | -7.90E-03 | 0.083563 | 0.013501 | -0.119135 | 0.012848 | 0.450607*** | 0.166206 | 8.75E-03 | 0.011288 |
| e3 | 0.030535*** | 0.020977*** | 1.82E-03 | -9.34E-03 | -0.164286 | 9.59E-03 | -0.083018 | 0.112653 | -0.371207* | 0.022591 | 0.094054*** | 0.075367** |
| e4 | 0.010967 | 6.21E-04 | -2.49E-03 | -0.026969 | 0.05052 | 2.75E-03 | 0.083783* | -0.106281 | 0.08588 | 0.119152*** | -0.021994 | -0.059481** |
| e5 | 0.166847*** | 0.157024*** | -0.084667 | 0.203517*** | -0.910657** | 0.080566 | -0.261775 | 0.212322 | -0.870099* | 0.198651* | -0.117185 | -0.021 |
| e6 | -0.091129** | 0.058683** | 0.329935*** | 0.185076* | 3.81542*** | 0.014338 | 2.47415*** | 0.903024* | 3.76676*** | 0.560606*** | 0.233106** | -0.313443*** |
| e7 | -0.010103 | 9.95E-03* | -0.023531 | 4.65E-03 | 0.20924* | 3.70E-03 | -1.56E-03 | 0.463867** | -0.305141*** | 0.073699 | -0.04406* | 0.039942 |
| e8 | -4.88E-03 | -8.79E-03*** | -0.037441* | -0.027431 | 0.235724 | -0.013758 | -8.79E-03 | -0.138637 | 0.302487** | 0.059578 | -0.052104*** | 0.075301 |
| e9 | 0.033797*** | 9.35E-03 | -0.026553 | -0.056002 | -3.47E-03 | -0.024525 | 0.157675 | 0.056238 | 0.122789 | 0.210148* | 2.19E-03 | -0.068329* |
| e10 | -4.51E-04 | 2.00E-03* | 0.015147 | 4.08E-03 | 7.26E-03 | 9.01E-04 | 0.14997** | 0.075904* | -0.048038 | 0.042733 | -0.010549 | -7.34E-04 |
| e11 | 0.031662* | 0.010225 | -0.032003 | -0.02814 | -0.099696 | 0.102825* | -0.079434 | -0.368204* | 0.091968 | -0.027341 | -0.02911 | -0.049832 |
| e12 | -1.53151*** | -0.015387 | -0.305044*** | -0.646939*** | -29.9444*** | -0.288533*** | -15.6939*** | -2.93581*** | -33.2602*** | -3.57781*** | -0.270038*** | -0.29756*** |
| e13 | 0.397054*** | -1.2537*** | 0.962133*** | 1.21474*** | 70.0823*** | 1.14729*** | 35.7895*** | 7.20015*** | 79.5117*** | 7.1347*** | 0.565585*** | 1.15985*** |
| e14 | 0.030813 | -4.16E-03 | -1.45695*** | 0.055697 | -0.643639* | -0.243712*** | 0.154793 | -0.305949 | -0.656303* | 0.432335** | 0.162114** | 6.76E-03 |
| e15 | -0.033892** | 4.47E-03 | 0.069752* | -1.34453*** | 0.9304*** | 0.097246* | 0.554787*** | -0.223238 | 0.739188*** | 0.035169 | 0.100896** | 0.019122 |
| e16 | -1.14E-03** | -1.46E-03*** | -1.44E-04 | -2.17E-03 | -0.54833*** | -3.85E-03*** | 0.218843*** | 0.024924** | 0.074349** | -0.018746 | -1.51E-03 | -7.33E-04 |
| e17 | 0.021271 | 0.033645 | -0.285772*** | 0.085171 | -1.96028*** | -0.875827*** | -0.915605*** | -0.543167 | -1.90407*** | -0.308768*** | -0.32189*** | -0.074406 |
| e18 | -4.25E-03*** | -1.71E-03*** | 0.013059** | 4.58E-04 | 0.430612*** | -1.67E-03 | -0.599283*** | 6.94E-03 | 0.043528 | -0.04602 | -0.012276*** | -3.45E-03 |
| e19 | 8.30E-03 | -4.46E-03 | -0.030483 | -0.051989 | 0.313293*** | -0.042717 | 0.071522 | -0.862656*** | -0.122044 | -0.022276 | -0.021397 | -0.164967*** |
| e20 | 1.04E-04 | -4.06E-05 | 6.61E-04 | -6.73E-03*** | 0.065756** | -5.77E-04 | 0.018059 | -0.019645** | -1.03421*** | -6.25E-04 | 1.37E-03 | 2.69E-03* |
| e21 | -0.018326*** | -5.41E-03* | 0.066751*** | -0.011177 | -0.118662 | -0.015238 | -0.194803 | -0.024162 | 0.060508 | -0.987745*** | -0.021841 | -8.41E-03 |
| e22 | 0.014509 | -0.02931 | 0.22102** | 0.139269** | -0.490145 | -0.370322*** | -0.782456** | -0.26157 | -0.238229 | -0.263866 | -1.00527*** | 0.027473 |
| e23 | 0.044087* | 8.62E-03 | 0.014652 | 2.84E-03 | -0.070123 | -0.04043 | -0.128279 | -1.14872*** | 0.173054 | -0.066508 | 0.022035 | -0.936718*** |

Table 5.10 Own and Cross Price Elasticities Across Both Stages.

| | p1 | p2 | p3 | p4 | p5 | p6 | p7 | p8 | p9 | p10 | p11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p1 | -2.86874*** | 0.239049 | 0.255253** | 0.412342** | 0.063058 | 0.100998 | -0.716556** | 0.575023** | -0.600091*** | -0.429377 | 0.477307*** |
| p2 | -0.229889*** | -0.070087 | -0.212493*** | 0.015766 | -0.137902*** | 0.294459*** | -0.117078 | -0.4305*** | 0.014648 | 0.077767 | -0.012656 |
| p3 | -0.021309 | -0.507363*** | -3.67913*** | 0.110247 | 0.011802 | 0.1485*** | 0.221117 | 0.059092 | 0.691058*** | 0.230588 | 0.174437** |
| p4 | -0.123359*** | 0.018054 | 0.010381 | -2.01616*** | -0.064385 | 0.320625*** | -0.048935 | 0.052848 | 0.084507 | -4.22E-03 | -8.02E-03 |
| p5 | -0.027292 | -0.166372 | 0.085781 | 0.073483 | -5.00045*** | 0.561751*** | -0.054394 | 0.054116 | 0.044516 | 0.317599 | -0.333238 |
| p6 | -0.03609 | -0.365674* | 0.120086 | 0.713122*** | 0.80649*** | -2.17425*** | -0.268617 | 0.552811** | 0.175371 | 0.582271 | 0.141403 |
| p7 | -0.306851*** | -0.143151 | 0.042993 | -0.034928 | -0.105507* | 0.22791*** | -1.59967*** | 0.170807 | 0.476808*** | -0.137383 | 0.059757 |
| p8 | -0.250094*** | -0.367989*** | -0.045331 | 0.026777 | -0.119165* | 0.451984*** | 0.106749 | -0.159946 | 0.018527 | 0.106121 | -0.037967 |
| p9 | -0.277077*** | 0.041503 | 0.415835*** | 0.123995* | -0.052172 | 0.188408*** | 0.792847*** | 0.073034 | -2.27836*** | 0.26702 | 1.74E-03 |
| p10 | -1.0261*** | 0.011486 | -0.154539*** | 0.0186 | -0.387278* | 1.73537*** | -0.027223 | 0.039375 | 0.024105 | -3.89284*** | 0.027951 |
| p11 | -0.025034 | -0.018703 | 0.098838** | 7.78E-04 | -0.207748** | 0.162075** | 0.122599 | -0.079563 | 2.70E-03 | 0.235095* | -1.9027*** |
| p12 | 0.123759* | 0.017513 | 0.155945** | 0.254182* | 0.732363*** | -0.208684* | -0.221416 | -0.028015 | 0.449424*** | -0.127059 | 0.373348* |
| p13 | 0.354597*** | -0.020651 | 0.188659 | 0.193651 | 1.72092*** | 0.67548*** | 0.553304* | -0.372799 | 0.321616* | 0.464967 | 0.332331 |
| p14 | 0.089134* | -0.253421 | -0.034722 | -2.32E-03 | -0.175705 | 0.294049*** | -0.164884 | -0.343172 | -0.117943 | 0.582236 | -0.121269 |
| p15 | -0.068107 | -0.061376 | -0.055806 | -0.115409 | 0.217915** | 0.135891* | 0.021796 | -0.202023 | -0.201004* | 0.116814 | -0.091183 |
| p16 | -1.79204*** | 3.63E-03 | -0.288619*** | 0.038468*** | -0.701911* | 3.13974*** | 0.016359 | 0.051791** | -8.18E-04 | 2.39E-03 | 0.013281 |
| p17 | -0.113033 | 0.120346 | -0.014109 | 0.030678 | 0.091532 | 9.40E-03 | 0.024152 | -0.114814 | -0.120876 | 0.015715 | 0.405918* |
| p18 | -0.94352*** | -0.032793 | -0.152843*** | 0.025062*** | -0.365611* | 1.59929*** | -5.14E-03 | 3.92E-03 | 0.012374 | 0.161088** | -4.76E-03 |
| p19 | -0.080675 | 9.24E-03 | 3.26E-03 | -0.080913 | -0.041065 | 0.357616*** | 0.412091** | -0.184715 | 0.021639 | 0.395973* | -0.183558* |
| p20 | -2.00649*** | 0.040799** | -0.328716*** | 0.045996*** | -0.780635* | 3.52067*** | -0.029026** | 0.059712*** | 6.91E-03 | -0.025467 | 0.02617 |
| p21 | -0.26414*** | 0.180142 | -0.028779 | 0.082862*** | -0.043701 | 0.316261*** | 0.060716 | 0.079687 | 0.106103 | 0.221744 | -0.022072 |
| p22 | 0.115299 | 0.091885 | 0.290309** | -0.143294 | -0.293439 | 0.280832** | -0.406229* | -0.655136*** | 5.37E-03 | -0.592286 | -0.144189 |
| p23 | 0.088067 | 0.080443 | 0.148176* | -0.288535* | -0.073168 | -0.263695*** | 0.244136 | 0.724164* | -0.266181** | -0.04662 | -0.16979 |

Table 5.10 cont. Own and Cross Price Elasticities Across Both Stages.

| | p12 | p13 | p14 | p15 | p16 | p17 | p18 | p19 | p20 | p21 | p22 | p23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| p1 | -0.399618*** | 0.51163*** | 0.152643*** | 0.038233 | 0.266626 | -0.105586 | 0.017164 | 1.41718*** | 0.042969 | -0.210611 | 0.118967* | 0.192534* |
| p2 | -3.15875*** | 6.89534*** | -0.135907*** | 0.068506*** | 0.08925 | -0.202735*** | -0.111181 | 0.022827 | 0.451922*** | 0.172703 | -0.081699 | -0.028399 |
| p3 | -1.08301*** | 2.01076*** | -0.058758 | 4.42E-03 | 0.17052 | -0.09297*** | 0.104903 | 0.166555 | -0.011639 | 0.070609 | 0.030084 | 0.041971 |
| p4 | -2.10092*** | 4.38644*** | -0.088019*** | 0.012348 | 4.12E-03 | -0.156876*** | 0.067918 | -0.100877 | 0.026068 | 0.120808*** | -0.100995*** | -0.099258*** |
| p5 | -0.541049*** | 1.16078*** | -0.132549 | 0.21601*** | -0.11232 | 1.60E-03 | 0.176294* | 0.330103 | -2.69E-03 | 0.306788*** | -0.172379* | -0.047273 |
| p6 | -0.608558*** | 0.517359*** | 0.22113** | 0.124676 | 0.189868 | -0.115789 | 0.669413*** | 0.579995 | -0.34697* | 0.222267 | 0.133184 | -0.407588*** |
| p7 | -2.59528*** | 5.53009*** | -0.118189*** | 0.061011 | 0.21108* | -0.181082*** | 5.67E-03 | 0.473554** | -0.309338*** | 0.07985 | -0.127959*** | 6.32E-04 |
| p8 | -3.76324*** | 8.31806*** | -0.157107*** | 0.069424*** | 0.208575 | -0.263376*** | -0.018491 | -0.131693 | 0.267812** | 0.062967 | -0.149786** | 0.034693 |
| p9 | -1.59616*** | 3.23941*** | -0.101711*** | -0.032017 | -6.27E-03 | -0.157788*** | 0.166833 | 0.068401 | 0.109324 | 0.218004* | -0.070924* | -0.107142*** |
| p10 | -14.4267*** | 33.8254*** | -0.330917*** | 0.481071*** | 8.86E-03 | -0.840737*** | 0.152699** | 0.109435*** | -0.047483 | 0.067429 | -0.231467 | -0.048615 |
| p11 | -1.39903*** | 2.76084*** | -0.103554** | -0.010941 | -0.125864* | -0.020266 | -0.080503 | -0.356853* | 0.050668 | -0.020707 | -0.100253** | -0.088892* |
| p12 | -1.77531*** | 0.023204 | 0.03603 | -0.110381* | -0.142047 | -0.029568 | -0.292728*** | 0.38795 | 0.024702 | -0.304036*** | -0.026556 | 0.117322 |
| p13 | -0.406344*** | -1.47563*** | -0.136972 | 0.164141 | -0.533211*** | 0.065712 | 0.023651 | 0.211365 | -0.031245 | 0.042662 | -0.248447* | 0.035598 |
| p14 | -0.497094*** | 0.539644*** | -1.50574*** | 0.066409 | 0.026625 | -0.320122*** | 0.543742** | -0.181799 | 0.052233 | 0.541981*** | 0.106766 | -0.021665 |
| p15 | -0.635986*** | 0.718737*** | -2.67E-03 | -1.36324*** | -0.098811 | -1.24E-03 | 0.066046 | -0.287981 | -0.450893*** | -0.041457 | 0.027554 | -0.035164 |
| p16 | -25.8943*** | 61.2223*** | -0.590593*** | 0.884193*** | -0.548443*** | -1.48339*** | 0.221427*** | 0.087537*** | 0.07323** | 0.028395 | -0.35541 | -0.056993 |
| p17 | -0.470002*** | 0.49307*** | -0.320619*** | 0.114106 | -0.26684** | -0.939589*** | 2.31E-03 | -0.304593 | -0.052976 | -0.086448 | -0.366528*** | -0.087271 |
| p18 | -13.3209*** | 31.1701*** | -0.309426*** | 0.437775*** | 0.427793*** | -0.781656*** | -0.59884*** | 0.037231* | 0.039054 | -0.023934 | -0.220376 | -0.050588 |
| p19 | -2.84607*** | 6.15917*** | -0.13179*** | 0.012437 | 0.240325** | -0.243147*** | 0.039814 | -0.860996*** | -0.209516** | -0.024095 | -0.109154* | -0.205645*** |
| p20 | -29.0234*** | 68.7037*** | -0.656502*** | 0.991437*** | 0.066179** | -1.65427*** | 0.021189 | 0.051103** | -1.03473*** | 0.052815** | -0.388826 | -0.055845 |
| p21 | -2.8689*** | 6.14936*** | -0.034234 | 0.053415** | -0.174031 | -0.215245*** | -0.217496 | -0.020645 | -7.23E-03 | -0.987709*** | -0.109373** | -0.048814* |
| p22 | -0.437521*** | 0.302617*** | 0.16716* | 0.149163** | -0.095485 | -0.451554*** | -0.518742** | -0.147112 | 0.146549 | -0.168622 | -1.06347*** | -5.41E-03 |
| p23 | -0.518195*** | 0.63436*** | -0.042611 | 2.64E-03 | -0.014368 | -0.124775 | -0.058001 | -1.09447*** | 0.196288* | -0.025424 | -0.039834 | -0.974472*** |

Table 5.11 Compensated Own and Cross Price Elasticities.

| | c1 | c2 | c3 | c4 | c5 | c6 | c7 | c8 | c9 | c10 | c11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| c1 | -2.72104*** | 0.066534 | 0.328552*** | 0.268609 | 0.168844 | 0.040327 | -0.851684*** | 0.250658 | -0.658014*** | -1.44068*** | 0.427663** |
| c2 | 0.033271* | -0.059215 | -0.151247** | 0.018091 | -0.020716 | -0.037998* | -0.10641 | -0.434387*** | 0.028272 | 0.08865 | -8.89E-04 |
| c3 | 0.121131*** | -0.521326*** | -3.62378*** | 0.092504 | 0.093377* | 0.056674 | 0.212541 | 2.56E-03 | 0.697572*** | 0.086794 | 0.18141*** |
| c4 | 0.074848*** | 0.038465 | 0.069414* | -2.00761*** | 0.019521 | 0.116349*** | -0.030246 | 0.055232 | 0.104331* | 0.042544 | 9.93E-03 |
| c5 | 0.106358 | -0.21941* | 0.150893* | 0.022622 | -4.912*** | 0.505287*** | -0.093938 | -0.076511 | 0.036674 | -0.052488 | -0.338831 |
| c6 | 0.176009* | 0.125446 | 0.400708*** | 1.004*** | 1.02915*** | -2.16312*** | 0.133369 | 1.02915*** | 0.443186** | 2.71727*** | 0.373612 |
| c7 | -0.080183** | -0.130321 | 0.101332 | -0.031122 | -4.79E-04 | -0.034376 | -1.58726*** | 0.167111 | 0.492106*** | -0.121284 | 0.073432 |
| c8 | 0.052335*** | -0.354312*** | 0.021397 | 0.030436 | 0.012405 | 0.046616** | 0.119554 | -0.159169 | 0.032952 | 0.133066 | -0.026002 |
| c9 | -0.106917*** | 0.060034 | 0.474732*** | 0.130414* | 0.037335 | 0.041256 | 0.810217*** | 0.067794 | -2.25826*** | 0.296157 | 0.020246 |
| c10 | -7.04E-03 | 0.018339 | 0.018192 | 6.62E-04 | 0.014677* | 0.013932 | -0.021749 | 0.027689 | 0.029511 | -3.88962*** | 0.022781* |
| c11 | 0.135156*** | 4.64E-03 | 0.160726*** | 9.56E-03 | -0.119238 | 0.038678 | 0.143973 | -0.082577 | 0.025885 | 0.281375** | -1.88142*** |
| c12 | 0.10904 | -3.29709*** | -0.580665*** | -2.00123*** | 0.442132 | -0.66948*** | -2.8957*** | -4.32259*** | -1.12027*** | -16.3041*** | -0.987624*** |
| c13 | 1.9712*** | 8.71177*** | 3.76912*** | 5.65387*** | 4.06052*** | 1.31803*** | 7.64184*** | 9.29081*** | 4.76327*** | 40.5361*** | 4.16234*** |
| c14 | 0.242695*** | -0.272 | 0.073238 | -0.04097 | -0.054549 | 0.250536*** | -0.175743 | -0.467437** | -0.102775 | 0.32238 | -0.107439 |
| c15 | 0.095586* | 0.110047 | 0.097353 | -0.025083 | 0.360505*** | 0.110893 | 0.16437 | -0.081676 | -0.095226 | 0.780924*** | 1.28E-03 |
| c16 | 3.64E-03* | 0.010749 | 7.03E-03 | 2.18E-04 | -1.90E-03 | 1.96E-03 | 0.020252* | 0.029 | -2.08E-04 | 5.81E-03 | -6.20E-03* |
| c17 | 0.035996 | -0.011974 | 0.068061 | -0.085559 | 0.201153 | -0.046615 | -0.078531 | -0.386753** | -0.159743 | -0.799106** | 0.372826* |
| c18 | 5.28E-04 | -0.02537 | 8.28E-03 | 9.45E-03 | 7.70E-03* | 0.014932*** | 9.72E-04 | -6.08E-03 | 0.018554 | 0.166951** | -8.28E-03 |
| c19 | 0.163861*** | 0.030062 | 0.065673 | -0.071945 | 0.071151 | 0.063509 | 0.43089** | -0.177679 | 0.040515 | 0.451973** | -0.167001 |
| c20 | 1.32E-03 | 0.047951*** | 6.27E-04 | 2.13E-03 | 8.72E-04 | -3.83E-03* | -0.025588*** | 0.033697** | 6.22E-03 | -0.02238 | 2.79E-03 |
| c21 | -0.020052 | 0.198909 | 0.03295 | 0.090491*** | 0.068059*** | 0.022385 | 0.077852 | 0.084245 | 0.123971* | 0.267999 | -6.38E-03 |
| c22 | 0.296396*** | 0.124343 | 0.446258*** | -0.158693 | -0.135026 | 0.23977** | -0.375026 | -0.751952*** | 0.05144 | -0.661539 | -0.104179 |
| c23 | 0.243364*** | 0.129018 | 0.269375*** | -0.280726* | 0.053173 | -0.30057*** | 0.287441 | 0.685452 | -0.219491* | 0.024498 | -0.128558 |

Table 5.11 cont. Compensated Own and Cross Price Elasticities.

| | c12 | c13 | c14 | c15 | c16 | c17 | c18 | c19 | c20 | c21 | c22 | c23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| c1 | 0.18101*** | 0.116372*** | 0.247657*** | 0.032817 | -1.77873*** | 0.030087 | -1.11012*** | 1.13791*** | -2.15751*** | -0.473332*** | 0.217802*** | 0.255188*** |
| c2 | 0.011375*** | 3.75E-03 | -0.022624 | -4.82E-03 | 0.084668 | 0.021317* | -0.121364 | 0.011129 | 0.456297*** | 0.166169 | 0.014692 | 0.016953 |
| c3 | 0.062887*** | 0.032821*** | 0.022642 | 2.82E-04 | -0.160834 | 0.034002 | -0.089977 | 0.107284 | -0.353434* | 0.022476 | 0.112604*** | 0.093062*** |
| c4 | 0.026844*** | 6.43E-03 | 7.73E-03 | -0.022247 | 0.052214 | 0.014727 | 0.080367* | -0.108916 | 0.094603* | 0.119096*** | -0.012891 | -0.050798* |
| c5 | 0.223464*** | 0.17775*** | -0.048233 | 0.220355*** | -0.904616** | 0.123284 | -0.273954 | 0.202925 | -0.838996* | 0.198451* | -0.084723 | 9.97E-03 |
| c6 | 5.15E-03 | 0.093928*** | 0.391892*** | 0.213709*** | 3.82569*** | 0.08698 | 2.45344*** | 0.887045* | 3.81965*** | 0.560266*** | 0.288307*** | -0.260786** |
| c7 | 2.69E-03 | 0.014631** | -0.015297 | 8.46E-03 | 0.210606* | 0.013351 | -4.31E-03 | 0.461743** | -0.298112*** | 0.073654 | -0.036724 | 0.04694 |
| c8 | 3.76E-03 | -5.62E-03* | -0.031878 | -0.02486 | 0.236647 | -7.24E-03 | -0.010649 | -0.140072 | 0.307236** | 0.059547 | -0.047148*** | 0.080029* |
| c9 | 0.05484*** | 0.017051*** | -0.013012 | -0.049744 | -1.23E-03 | -8.65E-03 | 0.153149 | 0.052745 | 0.134349 | 0.210073* | 0.014255 | -0.05682 |
| c10 | 1.74E-03 | 2.80E-03*** | 0.016557 | 4.73E-03 | -3.24E-03*** | 2.55E-03 | 0.149498** | 0.07554* | -0.046835 | 0.042725 | -9.29E-03 | 4.64E-04 |
| c11 | 0.055989*** | 0.019131 | -0.016348 | -0.020906 | -0.097101 | 0.12118** | -0.084667 | -0.372242* | 0.105332 | -0.027426 | -0.015162 | -0.036527 |
| c12 | -1.25062*** | 0.087443*** | -0.124284 | -0.563402*** | -29.9144*** | -0.076595 | -15.7543*** | -2.98243*** | -33.1059*** | -3.5788*** | -0.108986 | -0.143932 |
| c13 | 1.09553*** | -0.998006*** | 1.41162*** | 1.42247*** | 70.1569*** | 1.6743*** | 35.6393*** | 7.08423*** | 79.8955*** | 7.13224*** | 0.966062*** | 1.54186*** |
| c14 | 0.118183*** | 0.02782* | -1.40072*** | 0.081681 | -0.634317* | -0.17779** | 0.135999 | -0.32045 | -0.608306* | 0.432027** | 0.212208*** | 0.054542 |
| c15 | 0.038579** | 0.031*** | 0.116389*** | -1.32298*** | 0.938133*** | 0.151926*** | 0.554787*** | -0.235266 | 0.779*** | 0.034913 | 0.142448*** | 0.058759 |
| c16 | 7.55E-05 | -1.01E-03*** | 6.38E-04 | -1.81E-03 | -0.5482*** | -2.93E-03** | 0.218582*** | 0.024722** | 0.075016** | -0.01875 | -8.14E-04 | -6.81E-05 |
| c17 | 0.118638*** | 0.069289*** | -0.223114*** | 0.114128 | -1.94969*** | -0.802362*** | -0.936549*** | -0.559327 | -1.85058*** | -0.309111*** | -0.266063*** | -0.021153 |
| c18 | -1.88E-03** | -8.40E-04 | 0.014588** | 1.16E-03 | 0.430865*** | 1.19E-04 | -0.599794*** | 6.54E-03 | 0.044833 | -0.046028 | -0.010914** | -2.15E-03 |
| c19 | 0.019823 | -2.39E-04 | -0.023065 | -0.048561 | 0.314523*** | -0.03402 | 0.069042 | -0.864569*** | -0.115712 | -0.022317 | -0.014788 | -0.158663*** |
| c20 | 1.19E-03*** | 3.56E-04 | 1.36E-03 | -6.41E-03*** | 0.065872** | 2.41E-04 | 0.017826 | -0.019825** | -1.03362*** | -6.29E-04 | 1.99E-03 | 3.28E-03*** |
| c21 | -6.78E-03* | -1.18E-03 | 0.074178*** | -7.74E-03 | -0.11743 | -6.53E-03 | -0.197286 | -0.026078 | 0.066849 | -0.987785*** | -0.015223 | -2.09E-03 |
| c22 | 0.131463*** | 0.013505 | 0.296282*** | 0.174051** | -0.477666 | -0.282079*** | -0.807614** | -0.280981 | -0.17398 | -0.264278 | -0.93821*** | 0.091438 |
| c23 | 0.12362*** | 8.62E-03 | 0.065833 | 0.026493 | -0.081638 | 0.019578 | -0.145387 | -1.16192*** | 0.216745 | -0.066789 | 0.067636 | -0.89322*** |

Table 5.12 Expenditure Elasticities At The Second Stage and Across Both Stages.

| Elasticity At 2nd Stage | Estimate | Elasticity Across Both Stages | Estimate |
|---|---|---|---|
| Y1 | 1.44086*** | YB1 | 1.54441*** |
| Y2 | 1.03525*** | YB2 | 1.1388*** |
| Y3 | 1.68734*** | YB3 | 1.79089*** |
| Y4 | 0.531108*** | YB4 | 0.634659*** |
| Y5 | 1.54088*** | YB5 | 1.64443*** |
| Y6 | 0.114093 | YB6 | 0.217643** |
| Y7 | 0.956073*** | YB7 | 1.05962*** |
| Y8 | 0.088717 | YB8 | 0.192267 |
| Y9 | 0.942211*** | YB9 | 1.04576*** |
| Y10 | 1.45069*** | YB10 | 1.55424*** |
| Y11 | 0.862918*** | YB11 | 0.966468*** |
| Y12 | 1.8424*** | YB12 | 1.94595*** |
| Y13 | 0.674468*** | YB13 | 0.778018*** |
| Y14 | 1.18562*** | YB14 | 1.28917*** |
| Y15 | 0.547932*** | YB15 | 0.651482*** |
| Y16 | 0.196576** | YB16 | 0.300126*** |
| Y17 | 1.39012*** | YB17 | 1.49367*** |
| Y18 | -0.39632*** | YB18 | -0.29277*** |
| Y19 | -0.305783 | YB19 | -0.202233 |
| Y20 | 1.01213*** | YB20 | 1.11568*** |
| Y21 | -6.50E-03 | YB21 | 0.097053 |
| Y22 | 1.05636*** | YB22 | 1.15991*** |
| Y23 | 1.00766*** | YB23 | 1.11121 |

Table 5.13 Own and Cross Substitution Elasticities

| | s1 | s2 | s3 | s4 | s5 | s6 | s7 | s8 | s9 | s10 | s11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| s1 | -49.5821*** | 5.48038* | 6.67727*** | 8.17094*** | 3.32308 | 2.08374 | -11.9916** | 10.6351** | -9.81403*** | -6.35431 | 9.7622*** |
| s2 | 5.48038* | -10.5321 | -27.5772*** | 3.70951 | -4.21896 | -5.86869 | -18.8538 | -76.3075*** | 5.10366 | 15.4835 | -6.08E-03 |
| s3 | 6.67727*** | -27.5772*** | -206.369*** | 7.13743* | 5.16953* | 4.34436* | 13.8856 | 3.62935 | 40.8402*** | 14.6428 | 11.3822*** |
| s4 | 8.17094*** | 3.70951 | 7.13743* | -232.964*** | 3.13377 | 14.3097*** | -4.04766 | 6.45928 | 11.8107* | 1.08773 | 0.983147 |
| s5 | 3.32308 | -4.21896 | 5.16953* | 3.13377 | -159.845*** | 17.6469*** | -0.61978 | 1.96381 | 2.70648 | 11.8201 | -9.63026 |
| s6 | 2.08374 | -5.86869 | 4.34436* | 14.3097*** | 17.6469*** | -41.3942*** | -4.0696 | 10.7391** | 4.48547 | 12.6132 | 3.78056 |
| s7 | -11.9916** | -18.8538 | 13.8856 | -4.04766 | -0.61978 | -4.0696 | -228.543*** | 24.9078 | 70.8873*** | -18.1705 | 10.6871 |
| s8 | 10.6351** | -76.3075*** | 3.62935 | 6.45928 | 1.96381 | 10.7391** | 24.9078 | -33.9224 | 6.70627 | 24.3125 | -5.72842 |
| s9 | -9.81403*** | 5.10366 | 40.8402*** | 11.8107* | 2.70648 | 4.48547 | 70.8873*** | 6.70627 | -197.721*** | 24.9242 | 1.85974 |
| s10 | -6.35431 | 15.4835 | 14.6428 | 1.08773 | 11.8201 | 12.6132* | -18.1705 | 24.3125 | 24.9242 | -3271.26*** | 19.3369* |
| s11 | 9.7622*** | -6.08E-03 | 11.3822*** | 0.983147 | -9.63026 | 3.78056 | 10.6871 | -5.72842 | 1.85974 | 19.3369* | -142.489*** |
| s12 | 2.61461*** | 1.18217* | 2.81807*** | 2.24607* | 6.53852*** | -1.04753 | -0.456753 | -0.069074 | 3.95476*** | 0.624093 | 3.38601** |
| s13 | 2.50986*** | 0.993654* | 2.22646*** | 1.06143 | 6.15366*** | 2.00086*** | 2.43143*** | -0.884012 | 1.81665*** | 2.67988*** | 1.76961** |
| s14 | 4.83731*** | -4.20538 | 1.35833 | 0.626374 | -1.40472 | 6.33754*** | -2.3946 | -7.06972 | -1.33877 | 13.7505 | -1.46187 |
| s15 | 1.66513 | -0.400391 | 0.774943 | -2.23225 | 8.04535*** | 3.36478* | 1.66222 | -4.95491 | -3.92001 | 4.44697 | -1.17723 |
| s16 | 5.0653 | 16.1631 | 9.93903 | 0.737493 | -3.44019 | 3.8408 | 30.6652* | 44.7568 | -0.304473 | 7.91537 | -9.29409* |
| s17 | 0.615931 | 3.40514 | 1.77462 | 1.24232 | 3.93627 | 0.398384 | 1.52648 | -2.01299 | -1.15979 | 1.76778 | 8.75317** |
| s18 | -0.063838 | -20.0359 | 5.6349 | 7.58766 | 5.37487 | 12.4345*** | 0.538985 | -4.19013 | 14.2932 | 127.544** | -6.42001 |
| s19 | 25.6019*** | 3.31685 | 9.34463 | -11.9788 | 10.566 | 10.8809 | 67.7413** | -29.2301 | 5.81839 | 64.9223* | -27.1752* |
| s20 | 1.8044 | 81.4828*** | 0.37841 | 4.09637 | 0.941289 | -5.61785 | -43.4545*** | 58.1977** | 10.6287 | -38.4904 | 4.88815 |
| s21 | -3.7565 | 30.5933 | 4.21305 | 14.1814*** | 10.1175*** | 4.33838 | 11.5629 | 13.0148 | 19.2941* | 37.0247 | -1.35956 |
| s22 | 4.29351*** | 2.55984 | 6.54638*** | -1.6159 | -2.55155 | 4.73151* | -5.34883 | -10.1719*** | 1.18135 | -7.86331 | -1.23314 |
| s23 | 5.20277*** | 3.01231 | 5.57165*** | -5.99585* | 0.701656 | -6.07058*** | 6.75021 | 16.9492* | -4.99783 | 0.394931 | -2.81597 |

Table 5.13 Own and Cross Substitution Elasticities Cont.

| | s12 | s13 | s14 | s15 | s16 | s17 | s18 | s19 | s20 | s21 | s22 | s23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| s1 | 2.61461*** | 2.50986*** | 4.83731*** | 1.66513 | 5.0653 | 0.615931 | -0.063838 | 25.6019*** | 1.8044 | -3.7565 | 4.29351*** | 5.20277*** |
| s2 | 1.18217* | 0.993654** | -4.20538 | -0.400391 | 16.1631 | 3.40514 | -20.0359 | 3.31685 | 81.4828*** | 30.5933 | 2.55984 | 3.01231 |
| s3 | 2.81807*** | 2.22646*** | 1.35833 | 0.774943 | 9.93903 | 1.77462 | 5.6349 | 9.34463 | 0.37841 | 4.21305 | 6.54638*** | 5.57165*** |
| s4 | 2.24607** | 1.06143 | 0.626374 | -2.23225 | 0.737493 | 1.24232 | 7.58766 | -11.9788 | 4.09637 | 14.1814*** | -1.6159 | -5.99585* |
| s5 | 6.53852*** | 6.15366*** | -1.40472 | 8.04535*** | -3.44019 | 3.93627 | 5.37487 | 10.566 | 0.941289 | 10.1175*** | -2.55155 | 0.701656 |
| s6 | -1.04753 | 2.00086*** | 6.33754*** | 3.36478* | 3.8408 | 0.398384 | 12.4345*** | 10.8809 | -5.61785 | 4.33838 | 4.73151** | -6.07058*** |
| s7 | -0.456753 | 2.43143*** | -2.3946 | 1.66222 | 30.6652* | 1.52648 | 0.538985 | 67.7413** | -43.4545*** | 11.5629 | -5.34883 | 6.75021 |
| s8 | -0.069074 | -0.884012 | -7.06972 | -4.95491 | 44.7568 | -2.01299 | -4.19013 | -29.2301 | 58.1977** | 13.0148 | -10.1719*** | 16.9492* |
| s9 | 3.95476*** | 1.81665*** | -1.33877 | -3.92001 | -0.304473 | -1.15979 | 14.2932 | 5.81839 | 10.6287 | 19.2941* | 1.18135 | -4.99783 |
| s10 | 0.624093 | 2.67988*** | 13.7505 | 4.44697 | 7.91537 | 1.76778 | 127.544** | 64.9223* | -38.4904 | 37.0247 | -7.86331 | 0.394931 |
| s11 | 3.38601** | 1.76961** | -1.46187 | -1.17723 | -9.29409* | 8.75317** | -6.42001 | -27.1752* | 4.88815 | -1.35956 | -1.23314 | -2.81597 |
| s12 | -8.20291*** | 1.23785*** | 1.70749*** | 0.021741 | -0.731376 | 1.53771** | -2.3091*** | 2.27252 | 1.1775* | -1.96651*** | 1.25202** | 2.02347*** |
| s13 | 1.23785*** | -2.63249*** | 0.935409*** | 1.06672*** | -1.20839** | 1.69101*** | -0.330996 | 0.265758 | 0.93106** | 0.120139 | 0.547716 | 1.20047*** |
| s14 | 1.70749*** | 0.935409*** | -29.5375*** | 2.39828** | 0.769967 | -3.97266*** | 11.0924** | -4.04466 | 2.12435 | 11.5218*** | 4.55721*** | 1.34639 |
| s15 | 0.021741 | 1.06672*** | 2.39828** | -33.6333*** | -2.30107 | 3.13574** | 1.30987 | -7.51757 | -10.4377*** | -0.944361 | 3.28488*** | 1.07419 |
| s16 | -0.731376 | -1.20839** | 0.769967 | -2.30107 | -830.953*** | -4.84189** | 332.308*** | 38.694** | 112.796** | -27.4988 | -1.29867 | -0.123169 |
| s17 | 1.53771** | 1.69101*** | -3.97266*** | 3.13574** | -4.84189** | -15.1824*** | -0.332184 | -5.98247 | 0.019376 | -1.55166 | -4.76606*** | 0.069679 |
| s18 | -2.3091*** | -0.330996 | 11.0924** | 1.30987 | 332.308*** | -0.332184 | -465.275*** | 6.09492 | 31.7057 | -34.9861 | -8.55105** | -1.7151 |
| s19 | 2.27252 | 0.265758 | -4.04466 | -7.51757 | 38.694** | -5.98247 | 6.09492 | -138.193*** | -32.3953** | -3.86465 | -2.54874 | -25.5576*** |
| s20 | 1.1775* | 0.93106** | 2.12435 | -10.4377*** | 112.796** | 0.019376 | 31.7057 | -32.3953** | -1757.14*** | -0.060968 | 3.32879 | 5.57103** |
| s21 | -1.96651*** | 0.120139 | 11.5218*** | -0.944361 | -27.4988 | -1.55166 | -34.9861 | -3.86465 | -0.060968 | -157.672*** | -2.58569 | -0.487903 |
| s22 | 1.25202** | 0.547716 | 4.55721*** | 3.28488*** | -1.29867 | -4.76606*** | -8.55105** | -2.54874 | 3.32879 | -2.58569 | -14.7798*** | 1.51566 |
| s23 | 2.02347*** | 1.20047*** | 1.34639 | 1.07419 | -0.123169 | 0.069679 | -1.7151 | -25.5576*** | 5.57103** | -0.487903 | 1.51566 | -20.6917*** |

Table 5.14 Previous Meat Demand Studies Elasticity Results.

| | Whole chicken | Parts & processed | Expenditure |
|---|---|---|---|
| **Whole chicken** | -0.677 | 0.426 | -0.248 |
| **Parts & Processed** | 0.464 | -0.610 | 0.827 |

| | |
|---|---|
| **Author(s):** | Chen & Veeman (1991) |
| **Model:** | AIDS |
| **Data:** | Agriculture Canada time series |
| **Country:** | Canada (1967-87) |
| **Elasticity Type:** | Uncompensated |

| | Beef | Pork | Chicken | Turkey | Expenditure |
|---|---|---|---|---|---|
| **Beef** | -0.77 | 0.12 | 0.21 | 0.07 | 0.93 |
| **Pork** | 0.19 | -0.82 | -0.08 | 0.02 | 1.01 |
| **Chicken** | 0.02 | 0.08 | -0.95 | 0.14 | 1.04 |
| **Turkey** | -0.22 | 0.16 | -0.16 | -0.09 | 0.99 |

| | |
|---|---|
| **Author(s):** | Reynolds & Goddard (1991) |
| **Model:** | AIDS |
| **Data:** | Agriculture Canada & Statistics Canada |
| **Country:** | Canada (1968-87) |
| **Elasticity Type:** | Uncompensated |
| **Before Structural Change:** | |

| | Beef | Pork | Chicken | Expenditure |
|---|---|---|---|---|
| **Beef** | -1.0482 | -0.1020 | -0.1150 | 1.2652 |
| **Pork** | 0.1176 | -0.8088 | -0.0673 | 0.7585 |
| **Chicken** | -0.1406 | -0.0948 | -0.1139 | 0.3493 |
| **After Structural Change:** | | | | |
| | **Beef** | **Pork** | **Chicken** | **Expenditure** |
| **Beef** | -0.7359 | -0.2646 | -0.1356 | 1.1361 |
| **Pork** | -0.3860 | -0.6756 | -0.0774 | 1.1391 |
| **Chicken** | 0.0055 | 0.1459 | -0.3342 | 0.1829 |

Table 5.14 cont.

| | |
|---|---|
| **Author(s):** | Nayga & Capps (1994) |
| **Model:** | Rotterdam |
| **Data:** | Weekly Scanner Data (retail firm) |
| **Country:** | USA (Houston) (1986-1988) |
| **Elasticity Type:** | Compensated |

| | Breast | Parts | Other Chicken | Expenditure |
|---|---|---|---|---|
| **Breasts** | -1.876 | 0.143 | 0.135 | 0.640 |
| **Parts** | 0.444 | -2.545 | 0.203 | 0.778 |
| **Other Chicken** | 0.233 | 0.112 | -2.248 | 0.963 |

| **Author(s):** | | Xu & Veeman (1995) | | |
|---|---|---|---|---|
| **Model:** | | AIDS & Rotterdam (gradual transition) | | |
| **Data:** | | Quarterly Statistics Canada | | |
| **Country:** | | Canada (1967-92) | | |
| **Elasticity Type:** | | Uncompensated | | |
| **AIDS (before structural change):** | | | | |
| | **Beef** | **Pork** | **Chicken** | **Expenditure** |
| **Beef** | -0.965 | -0.079 | -0.131 | 1.176 |
| **Pork** | 0.021 | -0.832 | -0.087 | 0.898 |
| **Chicken** | -0.241 | -0.103 | -0.0725 | 0.417 |
| **AIDS (after structural change):** | | | | |
| **Beef** | -0.797 | -0.221 | -0.191 | 1.209 |
| **Pork** | -0.358 | -0.694 | -0.110 | 1.161 |
| **Chicken** | 0.009 | 0.101 | -0.412 | 0.301 |
| **Rotterdam (before structural change):** | | | | |
| **Beef** | -0.978 | -0.095 | -0.127 | 1.201 |
| **Pork** | 0.028 | -0.803 | -0.088 | 0.863 |
| **Chicken** | -0.194 | -0.109 | -0.091 | 0.395 |
| **Rotterdam (after structural change):** | | | | |
| **Beef** | -0.799 | -0.225 | -0.225 | 1.248 |
| **Pork** | -0.338 | -0.649 | -0.158 | 1.148 |
| **Chicken** | -0.012 | 0.109 | -0.329 | 0.231 |

| **Author(s):** | Nayga (1995) |
|---|---|
| **Model:** | Quadratic Expenditure System |
| **Data:** | Consumer Expenditure Survey |
| **Country:** | USA (1992) |
| **Elasticity Type:** | Income |
| | **Income Elasticity** |
| **Whole chicken** | -0.167 |
| **Chicken Parts** | -0.131 |
| **Other Poultry** | -0.206 |

Table 5.14 cont.

| **Author(s):** | Eales (1996) |
|---|---|
| **Model:** | Ordinary & Inverse Differential AIDS |
| **Data:** | Quarterly Agriculture Canada and Camsim |
| **Country:** | Canada (1970-92) |
| **Elasticity Type:** | N/A |

| Ordinary AIDS (static): | | | | |
|---|---|---|---|---|
| | Beef | Pork | Chicken | Expenditure |
| Beef | -0.88 | Na | Na | 1.19 |
| Pork | Na | -0.79 | Na | 1.01 |
| Chicken | Na | Na | -0.30 | 0.40 |
| Ordinary AIDS (dynamic): | | | | |
| Beef | -0.84 | Na | Na | 1.02 |
| Pork | Na | -0.78 | Na | 1.19 |
| Chicken | Na | Na | -0.35 | 0.51 |
| Ordinary AIDS (consistent): | | | | |
| Beef | -0.81 | Na | Na | 0.98 |
| Pork | Na | -0.86 | Na | 1.27 |
| Chicken | Na | Na | -0.45 | 0.43 |
| Inverse Differential AIDS (static): | | | | |
| Beef | -1.43 | Na | Na | 1.04 |
| Pork | Na | -1.37 | Na | 0.88 |
| Chicken | Na | Na | -2.94 | 1.22 |
| Inverse Differential AIDS (dynamic): | | | | |
| Beef | -1.01 | Na | Na | 0.94 |
| Pork | Na | -1.15 | Na | 1.32 |
| Chicken | Na | Na | -1.08 | 0.74 |
| Inverse Differential AIDS (consistent): | | | | |
| Beef | -1.02 | Na | Na | 1.12 |
| Pork | Na | -0.93 | Na | 1.01 |
| Chicken | Na | Na | -0.96 | 0.74 |

| Author(s): | | | Eales; Hyde; and Schrader (1998) | | |
|---|---|---|---|---|---|
| Model: | | | Rotterdam | | |
| Data: | | | Quarterly USDA | | |
| Country: | | | USA (1980-96) | | |
| Elasticity Type: | | | Compensated | | |
| | Beef | Pork | Chicken | Turkey | Expenditure |
| Beef | -0.29 | 0.23 | 0.03 | 0.03 | 1.19 |
| Pork | 0.46 | -0.52 | 0.02 | 0.05 | 0.94 |
| Chicken | 0.07 | 0.06 | -0.14 | 0.01 | 0.78 |
| Turkey | 0.44 | 0.13 | 0.06 | -0.63 | 0.07 |

Table 5.14 cont.

| Author(s): | Parcell & Pierce (2000) |
|---|---|
| Model: | Inverse Demand Model |
| Data: | USDA Monthly Data |
| Country: | USA (1988-97) |
| Elasticity Type: | Price Flexibilities |

| **Short Run:** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | BL Breast | Ribbed Breast | Drums | Legs | Wings | Beef | Pork | Turkey |
| BL Breast | -0.35 | Na | Na | Na | Na | 0.17 | 0.24 | -0.03 |
| Ribbed Breast | Na | -0.37 | Na | Na | Na | 0.15 | 0.27 | -0.06 |
| Drums | Na | Na | 0.07 | Na | Na | 0.22 | -0.26 | 0.03 |
| Legs | Na | Na | Na | -0.07 | Na | -0.45 | 0.51 | 0.03 |
| Wings | Na | Na | Na | Na | -0.12 | 0.32 | -0.11 | 0.01 |
| **Long Run:** | | | | | | | | |
| BL Breast | -1.95 | Na | Na | Na | Na | Na | Na | Na |
| Ribbed Breast | Na | -1.85 | Na | Na | Na | Na | Na | Na |
| Drums | Na | Na | 0.27 | Na | Na | Na | Na | Na |
| Legs | Na | Na | Na | -0.78 | Na | Na | Na | Na |
| Wings | Na | Na | Na | Na | -1.50 | Na | Na | Na |

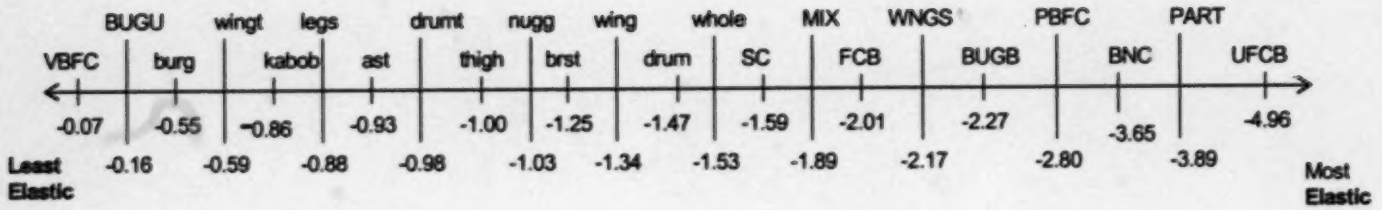
Table 5.15 Simulation Results.

| Variable | Product | Sim (1) | Sim (2) | Sim (3) | Sim (4) | Sim (5) |
|---|---|---|---|---|---|---|
| Qu1 (kg) | PBFC | 236831.3 | -6.51 | 0.21 | 2.68 | -0.13 |
| Qu2 (kg) | VBFC | 36865.3 | -4.54 | 0.31 | 1.54 | -0.24 |
| Qu3 (kg) | BNC | 47739.1 | -7.64 | 0.55 | 2.78 | -0.23 |
| Qu4 (kg) | FCB | 19950.6 | -2.63 | 0.19 | 0.67 | -0.32 |
| Qu5 (kg) | UFCB | 73090.8 | -8.87 | -1.40 | 5.04 | -0.50 |
| Qu6 (kg) | WNGS | 170773.3 | -0.98 | -0.75 | 1.28 | 0.12 |
| Qu7 (kg) | SC | 23671.3 | -4.17 | -0.52 | 1.63 | -0.80 |
| Qu8 (kg) | BUGU | 16169.6 | 1.82 | 0.63 | -2.00 | -1.50 |
| Qu9 (kg) | BUGB | 39074.7 | -4.13 | 0.10 | 1.39 | -0.40 |
| Qu10 (kg) | PART | 7527.1 | -6.34 | 0.01 | 2.17 | -0.75 |
| Qu11 (kg) | MIX | 68887.5 | -4.03 | 0.28 | 1.57 | 0.005 |
| Qu12 (kg) | whole | 881313.8 | -9.20 | 1.32 | 0.30 | -2.58 |
| Qu13 (kg) | brst | 1034082.3 | -2.82 | 1.51 | -0.29 | -0.07 |
| Qu14 (kg) | drum | 321412.7 | -5.54 | 0.57 | -0.03 | -1.97 |
| Qu15 (kg) | wing | 207354.0 | -2.30 | 1.42 | -0.23 | 0.15 |
| Qu16 (kg) | burg | 3338.6 | 0.42 | 0.01 | -1.09 | -0.82 |
| Qu17 (kg) | legs | 551801.5 | -6.96 | 0.62 | 0.28 | -2.27 |
| Qu18 (kg) | wingt | 6940.8 | 2.19 | 0.45 | -1.22 | 0.30 |
| Qu19 (kg) | kabob | 6625.4 | 14.16 | -0.89 | -7.60 | -1.75 |
| Qu20 (kg) | nugg | 3844.6 | -4.54 | 1.03 | -0.05 | -1.08 |
| Qu21 (kg) | drumt | 26841.1 | -0.67 | 1.17 | -0.90 | 0.004 |
| Qu22 (kg) | thigh | 317433.0 | -4.80 | 0.65 | -0.03 | -1.55 |
| Qu23 (kg) | ast | 257794.1 | -4.52 | 0.54 | 0.31 | -1.14 |
| PRODLC (slaughter) | N/A | 602681000 | 0.85 | -0.67 | -0.29 | 0.66 |
| Producer Surplus ($) | N/A | 518866000 | 0.19 | -0.16 | -0.10 | 0.15 |
| Marginal Cost ($/bird) | N/A | 1.17 | 0.96 | -0.75 | -0.33 | 0.74 |
| LTEXP ($) | N/A | 17.09 | -0.28 | 0.03 | 0.01 | -0.03 |
| Farm Supply (birds) | N/A | 602681000 | 0.85 | -0.67 | -0.30 | 0.66 |
| Quota Value ($/bird) | N/A | 0.27 | -4.15 | 3.26 | 1.41 | -3.21 |
| Processor Revenue | N/A | 7410237.5 | -4.91 | 0.71 | 0.31 | -0.64 |

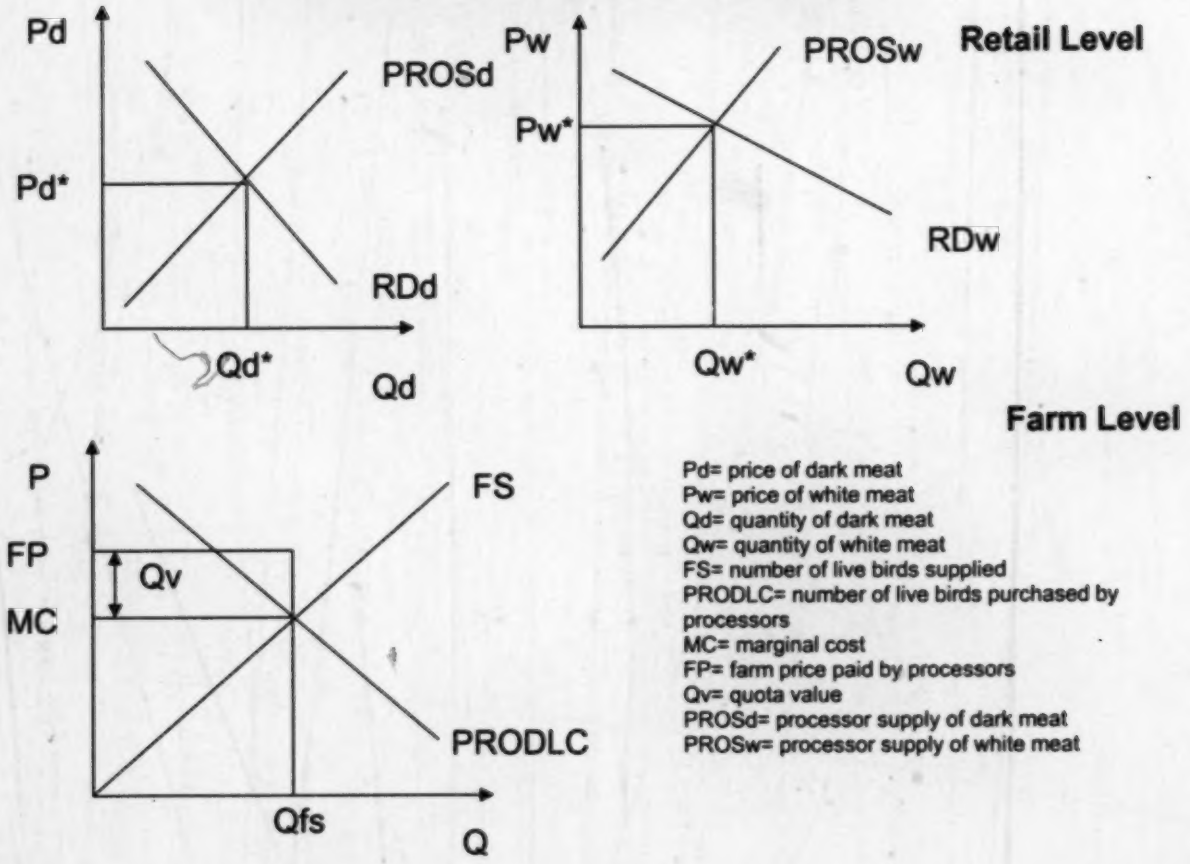
*Note: All numbers in Sim 2-5 represent the percent change from Sim 1

Sim(1) Base case results
Sim(2) Raise price of pork by 10%
Sim(3) Drop value of fresh white meat by 1%
Sim(4) Drop value of frozen parts by 1%
Sim(5) Raise value of fresh dark meat by 1%

Figure 5.1 Continuum of Own Price Elasticities At The Second Stage For All Product Groups



## Figure 5.2 Simulation Model Representation




Pd= price of dark meat
Pw= price of white meat
Qd= quantity of dark meat
Qw= quantity of white meat
FS= number of live birds supplied
PRODLC= number of live birds purchased by processors
MC= marginal cost
FP= farm price paid by processors
Qv= quota value
PROSd= processor supply of dark meat
PROSw= processor supply of white meat

## Chapter 6 Summary, Conclusions, and Limitations

### 6.1 Summary of Thesis

The Canadian retail demand for chicken products and parts was examined in this thesis. No other study in Canada has ever been done with such detailed product disaggregation. Previous studies have attempted to disaggregate chicken but usually into only two or three products and the models usually include other meats as well. Most importantly these studies focus were mainly in issues surrounding functional form, testing for structural change, or weak separability. This study only looked at chicken in order to provide unique results on individual products because whole bird consumption is not nearly as important as it once was, and chicken products are not homogeneous.

Chapter one provided a broad overview of the industry including per capita consumption, expenditure shares, statistics on where people eat chicken, and export and import figures. It also discusses how the export policy is used to remove large quantities of dark meat while retaining higher demand white meat domestically. The statement was made of how the country may be in a dark meat surplus and a white meat deficit. The chapter concluded with focused objectives that help accommodate the study.

In chapter two an in depth and comprehensive review of different aspects of the agricultural economics literature that are important for a demand study of the chicken industry is presented. The material covered basic consumer theory such as the six axioms, duality, and properties of Marshallian and Hicksian demand functions. Topics on how to model demand and the importance of weak separability were also covered. Since functional form is important in many papers the chapter listed in chronological order the advancements made in modeling, starting with the LES and advancing to PIGLOG and

rank three demand systems. Food away from home (FAFH) is becoming a more popular way to consume chicken as time goes on so household production theory was used to frame arguments on why more food is being consumed this way and the implications it has for the chicken industry. The chapter covered a review of previous meat demand studies especially ones from Canada, to set the stage for the introduction of scanner data as a new way to look at meat demand. An exhaustive review of previous scanner data papers was conducted with most of the review placed in tables allowing for a more condensed summary. The previous scanner papers illustrated the many interesting types of analysis that can be done with the data including evaluating the success of in store promotional experiments and designing more effective marketing strategies. Supply management plays a critical role in the Canadian poultry industry so an explanation of the production, price, import and export policy was done to explain how the industry is regulated. Supply management distorts the market and does not make it entirely competitive and many of the papers estimate the welfare impacts of the policy on producers and consumers. The competitive aspect of the market is further analyzed with a review of market power papers done on the meat industry in Canada and elsewhere. Most papers find market power in the Canadian industry but the degree and effect as well as the source are still in question. A look at new product development and a closer examination of the dark meat problem in Canada in the Canadian poultry industry was also included.

In the introduction of chapter three the objectives are narrowed and refocused to simplify the study, more will be said about the objectives in the next section. A detailed description of the AIDS model that was to be used in the estimation is presented in

Chapter 3. Utility trees and weak separability are also discussed and for this analysis it was assumed that chicken products are weakly separable from all other foods and all other meat. A table of different products that were estimated along with their abbreviated names and percent share of the total retail chicken market are given for the period of analysis in this study.

Chapter four describes the scanner data in detail and covers some of the recent consumption trends for the twenty three fresh and frozen products by analyzing the weekly fluctuations in price and quantity to give some indication of how the market has been changing for the overall demand profile. In Chapter 5 the results of the linear AIDS model estimation including own and cross price elasticities both compensated and uncompensated and substitution and expenditure elasticities are presented. Other results include seasonality and the effect of the BSE outbreak which proved interesting when looking at the individual product effects. To illustrate how the results can be used for policy analysis synthetic model simulations were conducted for the changing the price of pork and by changing the value of frozen, fresh white, and fresh dark meat products. The next section reviews the thesis objectives and attempts to provide clear answers for them based on the results.

## 6.2 Review of the Thesis Objectives

The first objective of the thesis was to analyze the national level scanner data to look at aggregate retail chicken consumption of both fresh and further processed products. The detailed examination was provided in chapter four including the percentage

share and consumption of fresh and frozen items. Basically the consumption trends for both general product groups are increasing but the rate of increase for frozen items is greater than for the fresh. Most of the new product development is occurring on the frozen side and people are still discovering many of these products and slowly incorporating more of them into their regular consumption patterns. The turnover rate for many of these frozen further processed items is high illustrating the rapid product development. When looking at the twenty three individual products with descriptive statistics it can be seen that consumption and price trends are unique for almost every product. Many of the products are price sensitive when additional quantity is placed on the market while others are not. From the trend graphs it can be seen how the data might be used for marketing strategies. Predictions on the elastic or inelastic nature of the products can also be undertaken from the descriptive statistics.

The second objective was to measure the price responsiveness of various chicken products through own, cross price and substitution elasticities. In chapter 5 own and cross price uncompensated elasticities for the model at the second stage and across both stages are presented. Compensated and substitution elasticities are also estimated and expenditure elasticities are given for both stages. The results show that frozen further processed items, which are mostly made out of white meat, are more price elastic then fresh chicken and that within the fresh group breast meat is more elastic then dark meat products. However, the own price elasticity for whole birds is the greatest among the fresh products. Objective three ties in with objective two regarding helping the industry to become more informed by providing information on demand elasticities at the domestic market level. Since white meat is more elastic lowering its price can raise

product consumption considerably but lowering the price of dark meat may not remove large quantities of additional product. If the goal of the industry was to expand chicken production it can use the elasticity results predicting what will happen to the retail prices and anticipate the success of an expanded production goal.

The fourth objective was to use the results to illustrate their use for policy analysis. A simulation model was constructed with all of the fresh and frozen products that occurred in the estimation. Price simulations illustrate how the model can be used to optimize the sale of chicken products by producers and processors. It gives an indication of how the chicken market would respond to increasing pork prices and how the welfare of producers changes when the price of frozen and fresh white meat are lowered to stimulate demand. A simulation raising the price of dark meat is also done to asses the impact of processors and producers. Although more simulations could be done this set highlights all of the important aspects of the study, first it uses the results of the estimates, second it studies an important policy driver in the marketing system and third it addresses the complex relationships that exist between white and dark meat. The next section goes over some broad ranging policy implications and describes potential ways that the industry can act by using the results of the analysis.

### 6.3 Policy Implications

From the simulation results it is evident that processors have a reasonably well functioning marketing system. If the values of different types of chicken meat are lowered to stimulate demand slaughter or farm supply drops but if the price of dark meat is raised it raises farm supply. Supply management's role is to stabilize producer price so

if processors were to charge less for white meat and frozen chicken products the quota value held by producers would increase to give the set price even though farm supply and producer surplus are lower. If the value of dark chicken products is increased, then producer surplus and farm supply increase but quota value drops. Food safety concerns are becoming more important especially with avian flu and health scares in the other meats like BSE in beef. A disastrous health event that shuts off exports would not be as detrimental to chicken producers as BSE was to cattle producers because of supply management, assuming domestic consumer confidence remains high. Exports are a growing but still relatively small proportion of total production and producers are insulated by the supply management system. The results show that overall chicken consumption increased after BSE but not across the board for all products.

Although overall chicken consumption is not tremendously seasonal, at the individual product level seasonality can be extreme. Not very much can be done about seasonality since people do not like to cook outdoors or prepare the same chicken products during all times of the year. The strategy of increasing product development will ensure that even though consumers may be changing what types of products they buy overall chicken consumption does not have to drop throughout the year. People tend to prefer more marinated breast meat in the winter, more ground chicken in the summer and more wings in the fall. If the industry is aware of the seasonal trends they can make sure an adequate supply of the product exists at the time when it is demanded.

From the simulation results and especially the descriptive statistics it can be seen that dark meat holds considerable development potential if further processing is done to it. A good example is wings which were once a very undesirable product but now has a

similar demand profile to breast meat. Skinless thighs and drums allows consumers to use dark meat in healthier cooking applications and by substituting dark meat into some further processed gourmet diners or breaded chicken applications it may allow the price to be raised and the consumers may not notice much difference. If the industry is going to add more value it must look to further processing options for dark meat because simply increasing supply of fresh legs or drums will only serve to lower price as illustrated by the inelasticity of many of the dark meat items. Concerns over dark chicken meat's high fat content is another challenge for the industry since Canadians are turning towards healthier diet choices like chicken breast meat as opposed to beef. Removing the skin of dark meat products and not frying the meat will go a long way in limiting fat intake associated with dark meat for people who otherwise enjoy it but are concerned about their diet.

The current policy is for the farmer to get paid a guaranteed price for every live bird which helps cover production costs and leaves enough for a "reasonable" return. However, the chicken board sells chicken as a homogeneous good regardless of the market agent who is purchasing it. Processors who buy live birds sell disaggregated chicken parts to the market and the revenue generated by selling the parts is greater then if the bird was sold whole. If the industry wanted to help producers increase producer surplus they may want to look at a different pricing mechanism that would allow them to market chicken in the same fashion as processors and retailers. One possibility is to move towards a type of grid based pricing system where white meat is priced differently on the bird than dark meat. It could also charge a different price for the birds depending on the end use. The industry may be able to charge the restaurants more than the retailers for

example, since restaurants tend to demand white meat for a certain size bird and sell it for at least twice as much as retail stores can sell it for. The restaurant industry drives many of the specifications that producers must fallow to provide desirable birds so it is not logical for the board to be charging the same price for all live birds. Producers could be better off if the marketing system was more in line with the demand profile of chicken and how it is actually sold to consumers. The results presented in this thesis illustrate the stark difference between chicken products and increases the level of information for the industry allowing it to have more information for the price negotiating process.

### 6.4 Limitations and Potential Areas of Further Study

Although the thesis is unique in its depth on one meat item it does not give a complete picture of consumer preferences towards meat because some individual product substitutability between different meat types probably occurs. Scanner data on beef and pork would have been good for looking at the effect of BSE and food safety concerns more closely. Making a demand model with a detailed product breakdown for other meat types would require many more equations and potential problems could emerge with the number of parameters relative to the number of data points. However, a longer and larger dataset could go a long way in allowing for more meat types or even estimating more sophisticated functional forms. The high cost of the scanner data is the main limitation in acquiring more of it and since ACNielsen discards older data by only keeping a three year running dataset means that a new dataset would have to be purchased every three

years. A regional comparison is also prohibitive for the same reasons as well. A regional breakdown could highlight differences in consumer preferences across the country. Scanner data is time series and as such does not include any demographic variables, however scanner data can be used to construct panels which can contain demographic variables. Including demographics would be interesting since we could find out what characteristics makes a person more prone to buying breast meat as opposed to whole birds or thighs. Would people with higher incomes and education show a stronger preference for white meat or would families with higher working hours be more likely to purchase frozen chicken items? National level scanner data is devoid of any demographic information but is highly informative and an econometrically powerful type of data. The export data was also a limitation because it was not detailed enough so that more products could have been included in the simulation model, mainly because it aggregates boneless and bone-in parts. A final potentially large drawback with this study is that good data on the restaurant industry is not available. In order to see the complete picture of the chicken industry restaurant sales should be included.

Future research may involve using survey data to come up with a rough indication of the restaurant purchases to try and more fully complete the picture of Canadian chicken demand. With respect to a marketing strategy the results could be used to simulate store level pricing games with different chicken products to see if profits or consumption could be increased by raising or lowering prices. Developing a model that could help the chicken board experiment with different pricing regimes could also be done in the future with more data.

Since market power may be present in the processing and retailing sectors in Canada it might be important take any market power relationships into account in a study of the chicken market. If market power exists but is not specified it could lead to invalid results and incomplete conclusions being drawn. More simulations could be done analyzing the affect of changing the quantity of exports since the export policy plays a role in the functioning of the market. If the country was to lose its ability to export it would be interesting to see how the market would respond at the domestic level. The composition of exports could also be experimented with to see if the retail prices for white and dark meat would be affected. The data used in this study was aggregated generally based on cut. Different demand estimations could be done on a brand level to capture the dynamics between store brand and brand name chicken products.

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## Appendix A: AC Nielsen Scanner Data Variables

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | pbfc11 | pbfc12 | vbfc11 | vbfc12 | bnc11 | bnc12 |
| Nov | 11 | 2000 | 1564057 | 181850.508 | 140144 | 32040.9432 | 602024 | 51450.034 |
| Nov | 18 | 2000 | 1646193 | 188537.479 | 138394 | 31093.3728 | 527966 | 42443.352 |
| Nov | 25 | 2000 | 1538367 | 178404.962 | 141895 | 33262.0344 | 508302 | 42801.696 |
| Dec | 2 | 2000 | 1548100 | 179004.622 | 146076 | 33357.2904 | 551191 | 45644.407 |
| Dec | 9 | 2000 | 1613203 | 190289.282 | 133999 | 31332.42 | 508369 | 40806.763 |
| Dec | 16 | 2000 | 1546781 | 179982.13 | 127556 | 30788.5536 | 535089 | 43701.638 |
| Dec | 23 | 2000 | 1659539 | 192474.274 | 119818 | 27759.4128 | 566390 | 47415.262 |
| Dec | 30 | 2000 | 1240859 | 145166.515 | 83446 | 19434.0384 | 359051 | 29722.594 |
| Jan | 6 | 2001 | 1724487 | 208890.965 | 132082 | 30413.4264 | 481053 | 38561.443 |
| Jan | 13 | 2001 | 1610179 | 186183.295 | 171927 | 39784.8024 | 567916 | 46294.87 |
| Jan | 20 | 2001 | 1892381 | 235398.442 | 168740 | 39455.0352 | 711941 | 61598.426 |
| Jan | 27 | 2001 | 1843203 | 229699.865 | 172525 | 43839.0792 | 559218 | 46145.635 |
| Feb | 3 | 2001 | 1732369 | 204727.37 | 236956 | 54055.512 | 647872 | 53137.879 |
| Feb | 10 | 2001 | 1705943 | 201311.762 | 150259 | 34003.2168 | 523293 | 41345.64 |
| Feb | 17 | 2001 | 1722542 | 199841.191 | 148213 | 34088.04 | 540547 | 43317.893 |
| Feb | 24 | 2001 | 1705235 | 198541.627 | 151038 | 34763.904 | 528024 | 42270.53 |
| Mar | 3 | 2001 | 1602685 | 185959.67 | 184183 | 42326.3232 | 600390 | 50189.933 |
| Mar | 10 | 2001 | 1522845 | 177486.422 | 160073 | 37846.116 | 488770 | 38678.472 |
| Mar | 17 | 2001 | 1389939 | 159019.459 | 170611 | 42035.112 | 530152 | 42277.334 |
| Mar | 24 | 2001 | 1689722 | 200997.871 | 153539 | 35127.2376 | 692598 | 58744.829 |
| Mar | 31 | 2001 | 1676856 | 198764.798 | 160258 | 36585.108 | 649366 | 55197.677 |
| April | 7 | 2001 | 1421964 | 166939.315 | 147957 | 33893.4456 | 632887 | 55360.973 |
| April | 14 | 2001 | 1259725 | 147219.962 | 126621 | 28829.0016 | 463347 | 37569.874 |
| April | 21 | 2001 | 1372106 | 164425.01 | 119450 | 26991.0144 | 436001 | 34920.396 |
| April | 28 | 2001 | 1406028 | 164224.066 | 139843 | 32665.5504 | 556283 | 45127.303 |
| May | 5 | 2001 | 1449551 | 165857.933 | 143028 | 32000.1192 | 480183 | 37721.376 |
| May | 12 | 2001 | 1256640 | 144060.638 | 160347 | 34939.9008 | 506381 | 41242.219 |
| May | 19 | 2001 | 1258492 | 143808.437 | 140115 | 31133.2896 | 456243 | 37148.479 |
| May | 26 | 2001 | 1187034 | 135470.815 | 127773 | 28443.8952 | 431293 | 33989.609 |
| June | 2 | 2001 | 1631105 | 189493.214 | 194370 | 41751.1584 | 519158 | 42529.082 |
| June | 9 | 2001 | 1335981 | 157819.234 | 147531 | 33410.3616 | 574734 | 50085.605 |
| June | 16 | 2001 | 1170831 | 133355.678 | 126644 | 28099.6128 | 409926 | 33088.306 |
| June | 23 | 2001 | 1193904 | 136397.974 | 132175 | 28773.2088 | 416319 | 33132.305 |
| June | 30 | 2001 | 1257119 | 146007.49 | 138500 | 30072.3192 | 431957 | 35631.641 |
| July | 7 | 2001 | 1287106 | 148801.212 | 137497 | 29745.2736 | 399645 | 30930.984 |
| July | 14 | 2001 | 1263140 | 144123.235 | 152566 | 32042.304 | 426913 | 32807.981 |
| July | 21 | 2001 | 1174423 | 134407.577 | 134222 | 28159.0344 | 388953 | 30667.896 |
| July | 28 | 2001 | 1189285 | 135257.623 | 121556 | 26189.0496 | 368949 | 29089.368 |
| Aug | 4 | 2001 | 1318923 | 152935.322 | 134745 | 28859.3928 | 496675 | 42448.795 |
| Aug | 11 | 2001 | 1108383 | 126681.862 | 117510 | 24827.796 | 353436 | 27596.57 |
| Aug | 18 | 2001 | 1195070 | 137409.048 | 118787 | 25065.4824 | 410460 | 33259.766 |
| Aug | 25 | 2001 | 1308101 | 149217.163 | 131272 | 27804.3192 | 439357 | 35239.73 |
| Sep | 1 | 2001 | 1540059 | 182517.754 | 225490 | 50003.5032 | 646529 | 54484.618 |
| Sep | 8 | 2001 | 1634434 | 195168.658 | 171999 | 37808.4672 | 489475 | 39529.426 |
| Sep | 15 | 2001 | 1602114 | 190205.82 | 150679 | 33680.7072 | 662010 | 58154.242 |
| Sep | 22 | 2001 | 1544967 | 183955.212 | 163411 | 36121.9824 | 501638 | 41342.918 |
| Sep | 29 | 2001 | 1395045 | 163510.553 | 147561 | 32015.088 | 457902 | 37223.323 |
| Oct | 6 | 2001 | 1413924 | 161480.693 | 149964 | 32623.3656 | 431756 | 33357.29 |
| Oct | 13 | 2001 | 1402700 | 161581.392 | 132167 | 29670.8832 | 402745 | 31862.678 |
| Oct | 20 | 2001 | 1693351 | 210732.581 | 144884 | 31432.212 | 514217 | 40874.803 |
| Oct | 27 | 2001 | 1591435 | 182727.317 | 159960 | 37487.3184 | 569734 | 46410.538 |
| Nov | 3 | 2001 | 1968145 | 247120.373 | 189111 | 42186.1608 | 580340 | 47461.529 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | pbfc11 | pbfc12 | vbfc11 | vbfc12 | bnc11 | bnc12 |
| Nov | 10 | 2001 | 1549515 | 180302.37 | 149533 | 32406.998 | 554123 | 44683.682 |
| Nov | 17 | 2001 | 1651214 | 210267.19 | 138889 | 29838.715 | 491901 | 40059.684 |
| Nov | 24 | 2001 | 1854545 | 238824.48 | 159496 | 34718.09 | 550162 | 45325.98 |
| Dec | 1 | 2001 | 1658290 | 192956 | 159784 | 34531.207 | 535381 | 43027.589 |
| Dec | 8 | 2001 | 1524399 | 176782.89 | 143276 | 30947.314 | 571965 | 47314.109 |
| Dec | 15 | 2001 | 1502672 | 177363.5 | 136980 | 29398.27 | 502837 | 41035.831 |
| Dec | 22 | 2001 | 1580844 | 184104.45 | 141394 | 30414.334 | 539774 | 43938.418 |
| Dec | 29 | 2001 | 1116801 | 130154.62 | 98896 | 21201.718 | 331198 | 26697.082 |
| Jan | 5 | 2002 | 1651622 | 195842.71 | 145392 | 32586.624 | 513080 | 41332.939 |
| Jan | 12 | 2002 | 1744867 | 206344.45 | 171033 | 37914.61 | 525101 | 40851.67 |
| Jan | 19 | 2002 | 1813544 | 215177.86 | 199583 | 44203.32 | 667772 | 54718.675 |
| Jan | 26 | 2002 | 1731830 | 204776.36 | 163265 | 37886.94 | 537964 | 43534.714 |
| Feb | 2 | 2002 | 2068340 | 286458.38 | 212765 | 46254.046 | 544441 | 43179.545 |
| Feb | 9 | 2002 | 1750642 | 203908.17 | 172122 | 36643.622 | 633018 | 52472.902 |
| Feb | 16 | 2002 | 1576490 | 182095.91 | 156955 | 35186.206 | 463862 | 37008.77 |
| Feb | 23 | 2002 | 1835577 | 213902.34 | 167499 | 36698.508 | 591535 | 47797.193 |
| Mar | 2 | 2002 | 2681221 | 393893.54 | 163330 | 34439.58 | 505280 | 39546.209 |
| Mar | 9 | 2002 | 1891909 | 239794.28 | 165240 | 35843.926 | 651076 | 55869.005 |
| Mar | 16 | 2002 | 1554680 | 178919.8 | 178138 | 43441.726 | 506505 | 39518.993 |
| Mar | 23 | 2002 | 1639471 | 194220.63 | 174385 | 40848.948 | 587235 | 48566.952 |
| Mar | 30 | 2002 | 1496394 | 173100.11 | 147545 | 30814.409 | 451994 | 35163.526 |
| April | 6 | 2002 | 1773966 | 220821.1 | 155370 | 32508.151 | 670991 | 59012.453 |
| April | 13 | 2002 | 1674141 | 206350.8 | 146251 | 31327.43 | 539347 | 43531.538 |
| April | 20 | 2002 | 1567024 | 188203.18 | 135795 | 28776.838 | 536322 | 45134.107 |
| April | 27 | 2002 | 1646699 | 207116.94 | 146678 | 31550.148 | 513748 | 42481.908 |
| May | 4 | 2002 | 1552057 | 186674.54 | 151189 | 32489.1 | 486240 | 38727.461 |
| May | 11 | 2002 | 1433555 | 165192.96 | 130010 | 27837.886 | 554036 | 44810.237 |
| May | 18 | 2002 | 1328140 | 151491.06 | 139732 | 30705.545 | 544009 | 43968.355 |
| May | 25 | 2002 | 1398382 | 161750.58 | 121466 | 26282.038 | 488030 | 40057.87 |
| June | 1 | 2002 | 1473389 | 169949.4 | 155050 | 32128.942 | 443668 | 35333.172 |
| June | 8 | 2002 | 1398958 | 162022.74 | 133057 | 27965.347 | 461041 | 36960.235 |
| June | 15 | 2002 | 1259481 | 141896.51 | 134479 | 29268.994 | 514498 | 42121.296 |
| June | 22 | 2002 | 1196087 | 135748.87 | 127817 | 27531.252 | 422765 | 33845.364 |
| June | 29 | 2002 | 1244954 | 140668.16 | 133437 | 28699.272 | 452094 | 37051.862 |
| July | 6 | 2002 | 1349630 | 156877.56 | 122669 | 25654.709 | 362628 | 29311.178 |
| July | 13 | 2002 | 1241815 | 140305.74 | 140052 | 29137.45 | 550871 | 49464.173 |
| July | 20 | 2002 | 1224479 | 138955.82 | 132023 | 27371.131 | 377002 | 30008.362 |
| July | 27 | 2002 | 1138487 | 128918.56 | 124420 | 25824.809 | 376021 | 30331.778 |
| Aug | 3 | 2002 | 1350267 | 156049.74 | 150704 | 30559.486 | 488966 | 41170.55 |
| Aug | 10 | 2002 | 1587565 | 219836.33 | 123122 | 26016.228 | 345656 | 28028.398 |
| Aug | 17 | 2002 | 1252798 | 145150.19 | 124390 | 26420.386 | 434050 | 35685.619 |
| Aug | 24 | 2002 | 1295599 | 149072.92 | 146940 | 31099.723 | 375106 | 29710.346 |
| Aug | 31 | 2002 | 1537179 | 177408.4 | 213593 | 42124.925 | 483562 | 40390.812 |
| Sep | 7 | 2002 | 1594392 | 188329.73 | 180943 | 38361.406 | 605381 | 51838.315 |
| Sep | 14 | 2002 | 1468636 | 177709.59 | 164687 | 33305.126 | 439208 | 35121.794 |
| Sep | 21 | 2002 | 1553236 | 188468.08 | 178509 | 35280.101 | 653822 | 58550.234 |
| Sep | 28 | 2002 | 1539455 | 179814.75 | 169557 | 35785.865 | 463698 | 37423.361 |
| Oct | 5 | 2002 | 1822300 | 215027.27 | 206487 | 44282.7 | 582861 | 49957.236 |
| Oct | 12 | 2002 | 1604229 | 186295.79 | 141966 | 28435.277 | 455916 | 36611.417 |
| Oct | 19 | 2002 | 1708765 | 211430.22 | 183057 | 35312.306 | 421908 | 34392.859 |
| Oct | 26 | 2002 | 1687330 | 197773.23 | 181512 | 40531.428 | 626865 | 54375.3 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | pbfc11 | pbfc12 | vbfc11 | vbfc12 | bnc11 | bnc12 |
| Nov | 2 | 2002 | 1896674 | 240938.712 | 204441 | 40430.275 | 515467 | 41525.719 |
| Nov | 9 | 2002 | 1710927 | 209259.742 | 173856 | 36398.678 | 498132 | 39497.22 |
| Nov | 16 | 2002 | 1750540 | 213344.863 | 163707 | 33993.691 | 505319 | 40573.613 |
| Nov | 23 | 2002 | 1890596 | 238650.754 | 166801 | 34135.214 | 651747 | 57445.265 |
| Nov | 30 | 2002 | 1742938 | 201948.163 | 181166 | 37324.476 | 514778 | 41671.325 |
| Dec | 7 | 2002 | 1950285 | 233412.581 | 181335 | 35640.259 | 626848 | 52772.278 |
| Dec | 14 | 2002 | 2162336 | 292794.264 | 152573 | 30516.847 | 459321 | 36627.746 |
| Dec | 21 | 2002 | 1757354 | 218487.78 | 166541 | 31612.745 | 557071 | 46001.39 |
| Dec | 28 | 2002 | 1227756 | 147459.463 | 108375 | 20986.258 | 364933 | 29919.456 |
| Jan | 4 | 2003 | 1768581 | 208246.399 | 175111 | 33665.738 | 474714 | 37557.173 |
| Jan | 11 | 2003 | 2056314 | 250438.003 | 239607 | 54839.333 | 734495 | 64327.284 |
| Jan | 18 | 2003 | 1839919 | 223587.151 | 232757 | 44434.656 | 523074 | 42139.44 |
| Jan | 25 | 2003 | 2076123 | 256069.447 | 183754 | 36212.249 | 569936 | 50687.986 |
| Feb | 1 | 2003 | 1893239 | 227522.585 | 240734 | 49630.19 | 712007 | 62195.364 |
| Feb | 8 | 2003 | 1799805 | 213381.605 | 248580 | 46070.338 | 540589 | 45340.949 |
| Feb | 15 | 2003 | 1705344 | 195609.557 | 213622 | 43329.686 | 605008 | 50313.766 |
| Feb | 22 | 2003 | 2476351 | 313570.958 | 205098 | 39699.072 | 503396 | 40009.334 |
| Mar | 1 | 2003 | 1946447 | 230612.508 | 203426 | 40596.746 | 542665 | 45729.23 |
| Mar | 8 | 2003 | 1800475 | 210199.601 | 232825 | 42492.341 | 611374 | 50501.102 |
| Mar | 15 | 2003 | 1804393 | 219503.844 | 185671 | 34870.046 | 505609 | 41211.828 |
| Mar | 22 | 2003 | 1994149 | 243384.07 | 185080 | 36415.462 | 528448 | 42956.374 |
| Mar | 29 | 2003 | 1679726 | 195841.8 | 185674 | 36882.67 | 648852 | 54451.051 |
| April | 5 | 2003 | 2500636 | 342327.838 | 211024 | 39745.339 | 519951 | 40912.906 |
| April | 12 | 2003 | 1944253 | 250920.18 | 204021 | 41620.068 | 481017 | 38624.494 |
| April | 19 | 2003 | 1513850 | 173657.585 | 171335 | 33203.52 | 568678 | 47100.463 |
| April | 26 | 2003 | 1493083 | 175101.394 | 182476 | 33791.386 | 407504 | 32558.047 |
| May | 3 | 2003 | 1688019 | 196730.856 | 214747 | 38595.463 | 639454 | 53522.532 |
| May | 10 | 2003 | 1989129 | 247108.579 | 189015 | 35015.198 | 499658 | 41227.704 |
| May | 17 | 2003 | 1442190 | 166693.918 | 191060 | 35636.63 | 500652 | 40648.91 |
| May | 24 | 2003 | 1467521 | 168970.082 | 165727 | 32113.973 | 485069 | 38576.412 |
| May | 31 | 2003 | 1583524 | 184474.13 | 215774 | 39021.847 | 449147 | 35980.459 |
| June | 7 | 2003 | 1515313 | 175280.566 | 211055 | 38971.951 | 587223 | 51276.305 |
| June | 14 | 2003 | 1368836 | 154520.201 | 218106 | 41819.652 | 413765 | 32915.03 |
| June | 21 | 2003 | 1371787 | 158692.414 | 178080 | 32656.025 | 458025 | 38422.642 |
| June | 28 | 2003 | 1361038 | 179941.759 | 161468 | 30189.348 | 364778 | 30276.893 |
| July | 5 | 2003 | 1293128 | 146784.053 | 203768 | 37074.542 | 444529 | 37953.166 |
| July | 12 | 2003 | 1342066 | 157816.512 | 201483 | 35093.218 | 381574 | 31191.35 |
| July | 19 | 2003 | 1433025 | 165862.015 | 187588 | 33947.878 | 462637 | 40560.912 |
| July | 26 | 2003 | 1366713 | 156310.56 | 144623 | 27885.06 | 434525 | 36413.647 |
| Aug | 2 | 2003 | 1366361 | 160086.326 | 161907 | 30897.871 | 381891 | 31621.363 |
| Aug | 9 | 2003 | 1382575 | 161641.721 | 180132 | 32427.41 | 451432 | 38095.596 |
| Aug | 16 | 2003 | 1421585 | 173771.892 | 133721 | 24985.195 | 347535 | 28579.522 |
| Aug | 23 | 2003 | 1674037 | 207155.491 | 148794 | 28631.686 | 380250 | 30449.261 |
| Aug | 30 | 2003 | 2313851 | 303678.396 | 227484 | 40921.07 | 450557 | 38839.5 |
| Sep | 6 | 2003 | 1745574 | 211521.391 | 207886 | 42568.999 | 625754 | 55946.117 |
| Sep | 13 | 2003 | 1722359 | 206897.846 | 176198 | 34924.025 | 654514 | 59221.562 |
| Sep | 20 | 2003 | 1808014 | 218290.918 | 214573 | 38832.696 | 465132 | 38138.688 |
| Sep | 27 | 2003 | 1487115 | 172193.818 | 193247 | 35383.068 | 566458 | 47473.776 |
| Oct | 4 | 2003 | 1843029 | 219589.574 | 183883 | 34613.309 | 476881 | 38238.934 |
| Oct | 11 | 2003 | 1515812 | 172483.214 | 197486 | 34303.954 | 430653 | 34265.851 |
| Oct | 18 | 2003 | 1766444 | 210693.118 | 142340 | 26279.77 | 409089 | 32855.155 |
| Oct | 25 | 2003 | 1828435 | 213842.009 | 243374 | 41635.49 | 515771 | 41875.445 |
| Nov | 1 | 2003 | 1983679 | 265201.776 | 186473 | 35800.38 | 468958 | 37661.954 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | fcb11 | fcb12 | ufcb11 | ufcb12 | wngs11 | wngs12 |
| Nov | 11 | 2000 | 190569 | 14282.9568 | 494717 | 44494.5312 | 1312097 | 143214.22 |
| Nov | 18 | 2000 | 176063 | 12980.2176 | 568482 | 54671.5008 | 1333903 | 143625.64 |
| Nov | 25 | 2000 | 162112 | 12300.7248 | 455499 | 39772.5552 | 1480569 | 165092.71 |
| Dec | 2 | 2000 | 170023 | 12809.2104 | 445321 | 39079.4544 | 1446756 | 161342.34 |
| Dec | 9 | 2000 | 181704 | 13403.88 | 455661 | 40752.3312 | 1422475 | 155449.17 |
| Dec | 16 | 2000 | 154654 | 11234.3112 | 388929 | 33564.132 | 1534418 | 149813.65 |
| Dec | 23 | 2000 | 147319 | 10587.9312 | 419836 | 36060.7464 | 2036217 | 195537.89 |
| Dec | 30 | 2000 | 108930 | 7817.3424 | 280972 | 23947.812 | 1592276 | 149890.31 |
| Jan | 6 | 2001 | 186431 | 13803.9552 | 524876 | 46517.5872 | 1392584 | 128225.92 |
| Jan | 13 | 2001 | 199040 | 14721.1344 | 2192876 | 221207.566 | 1284336 | 121709.95 |
| Jan | 20 | 2001 | 211866 | 16320.0744 | 691295 | 65188.2168 | 1420591 | 137130.08 |
| Jan | 27 | 2001 | 224559 | 18002.4768 | 665583 | 68097.6072 | 1725921 | 172959.04 |
| Feb | 3 | 2001 | 212801 | 16174.4688 | 638663 | 60494.8176 | 1512569 | 141822.12 |
| Feb | 10 | 2001 | 258397 | 22130.6904 | 602015 | 55267.0776 | 1250031 | 115747.83 |
| Feb | 17 | 2001 | 224836 | 17640.504 | 759858 | 70236.7848 | 1303038 | 118853.63 |
| Feb | 24 | 2001 | 213992 | 16623.5328 | 546860 | 49178.4048 | 1317728 | 121822.44 |
| Mar | 3 | 2001 | 231502 | 18383.5008 | 1565904 | 205452.223 | 1402621 | 131090.85 |
| Mar | 10 | 2001 | 220047 | 17550.2376 | 599988 | 56859.2136 | 1409095 | 135741.61 |
| Mar | 17 | 2001 | 216395 | 16322.3424 | 626185 | 61814.34 | 1259312 | 116465.88 |
| Mar | 24 | 2001 | 214796 | 16105.5216 | 539190 | 47484.2088 | 1275271 | 117298.24 |
| Mar | 31 | 2001 | 251779 | 22121.1648 | 688402 | 68862.8304 | 1323127 | 119944.54 |
| April | 7 | 2001 | 203459 | 15245.496 | 550837 | 49363.02 | 1350298 | 127422.14 |
| April | 14 | 2001 | 215848 | 16487.4528 | 501624 | 43629.0624 | 1250137 | 115091.47 |
| April | 21 | 2001 | 199477 | 15389.2872 | 474656 | 41342.4648 | 1056079 | 96635.398 |
| April | 28 | 2001 | 258959 | 19947.9672 | 2612908 | 266653.75 | 1269287 | 118331.54 |
| May | 5 | 2001 | 277175 | 20781.2304 | 713895 | 63571.1328 | 1348166 | 124610.72 |
| May | 12 | 2001 | 290191 | 21854.448 | 714155 | 62279.28 | 1325258 | 127243.42 |
| May | 19 | 2001 | 358116 | 28690.2 | 716966 | 63714.4704 | 1196517 | 108834.52 |
| May | 26 | 2001 | 326646 | 25654.2552 | 655570 | 57687.9408 | 1168004 | 105741.87 |
| June | 2 | 2001 | 334606 | 25247.376 | 762465 | 72947.952 | 1337043 | 121330.74 |
| June | 9 | 2001 | 372496 | 28485.6264 | 670737 | 61541.7264 | 1201400 | 109166.55 |
| June | 16 | 2001 | 482033 | 36660.4056 | 2238195 | 223180.726 | 1114748 | 99054.9 |
| June | 23 | 2001 | 407499 | 31266.1944 | 643209 | 56813.4 | 1407513 | 134750.95 |
| June | 30 | 2001 | 445130 | 33903.4248 | 754644 | 68216.4504 | 1322688 | 120344.16 |
| July | 7 | 2001 | 343631 | 25690.5432 | 722171 | 64723.7304 | 1259627 | 111730.3 |
| July | 14 | 2001 | 349364 | 26187.6888 | 2286991 | 234041.27 | 1166930 | 101123.32 |
| July | 21 | 2001 | 354011 | 26144.5968 | 697809 | 60895.8 | 1197580 | 107520.44 |
| July | 28 | 2001 | 312447 | 22979.8296 | 682586 | 60101.5464 | 1166005 | 101808.25 |
| Aug | 4 | 2001 | 329513 | 23916.06 | 685713 | 58843.26 | 1302154 | 115656.21 |
| Aug | 11 | 2001 | 336656 | 24650.4384 | 725225 | 66343.9896 | 1066527 | 92213.705 |
| Aug | 18 | 2001 | 293817 | 21211.6968 | 776816 | 77273.4816 | 1199868 | 104225.03 |
| Aug | 25 | 2001 | 287512 | 21286.0872 | 630792 | 55830.4488 | 1162032 | 100030.59 |
| Sep | 1 | 2001 | 306006 | 22573.8576 | 744173 | 68358.8808 | 1330345 | 114388.85 |
| Sep | 8 | 2001 | 281720 | 20710.0152 | 2433426 | 247709.146 | 1181223 | 101091.56 |
| Sep | 15 | 2001 | 268900 | 20334.4344 | 621817 | 55622.7 | 1249635 | 107998.53 |
| Sep | 22 | 2001 | 266015 | 20587.5432 | 683096 | 66976.308 | 1244810 | 108068.84 |
| Sep | 29 | 2001 | 238811 | 18767.2464 | 537623 | 48119.2488 | 1629194 | 153006.99 |
| Oct | 6 | 2001 | 222499 | 16862.58 | 519596 | 46832.3856 | 1379689 | 122261.53 |
| Oct | 13 | 2001 | 192813 | 15038.2008 | 460431 | 43611.372 | 1113759 | 94674.485 |
| Oct | 20 | 2001 | 222643 | 17358.3648 | 1917559 | 194105.419 | 1367691 | 117442.94 |
| Oct | 27 | 2001 | 201268 | 15237.3312 | 510092 | 44662.3632 | 1798384 | 164090.71 |
| Nov | 3 | 2001 | 199709 | 14892.1416 | 534843 | 47849.8104 | 1450261 | 126479.1 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | fcb11 | fcb12 | ufcb11 | ufcb12 | wngs11 | wngs12 |
| Nov | 10 | 2001 | 211302 | 15814.764 | 558050 | 50191.747 | 1368870 | 118065.73 |
| Nov | 17 | 2001 | 199512 | 14822.287 | 535237 | 51902.273 | 1344012 | 114809.79 |
| Nov | 24 | 2001 | 190891 | 14321.513 | 1688515 | 170989.06 | 1584340 | 141934.16 |
| Dec | 1 | 2001 | 213566 | 16925.63 | 554291 | 50865.343 | 1557623 | 133222.77 |
| Dec | 8 | 2001 | 201894 | 15588.418 | 805711 | 76999.507 | 1502970 | 130297.51 |
| Dec | 15 | 2001 | 182259 | 14262.998 | 424592 | 38108.75 | 1590709 | 140284.87 |
| Dec | 22 | 2001 | 170635 | 13159.843 | 416005 | 36838.67 | 2034165 | 177936.39 |
| Dec | 29 | 2001 | 123588 | 9536.4864 | 280850 | 24651.799 | 1625711 | 140117.04 |
| Jan | 5 | 2002 | 215330 | 16747.366 | 563475 | 49806.187 | 2032806 | 178486.16 |
| Jan | 12 | 2002 | 236217 | 18472.86 | 2496271 | 267116.42 | 1389278 | 118263.5 |
| Jan | 19 | 2002 | 210966 | 16194.427 | 1128043 | 132224.4 | 1507883 | 131629.73 |
| Jan | 26 | 2002 | 178945 | 13700.534 | 586477 | 53746.61 | 2016253 | 196734.48 |
| Feb | 2 | 2002 | 205666 | 16072.409 | 1694141 | 175804.47 | 2132534 | 184931.36 |
| Feb | 9 | 2002 | 216405 | 17143.358 | 645780 | 62560.512 | 1755726 | 149100.59 |
| Feb | 16 | 2002 | 174651 | 13143.06 | 1426584 | 144541.91 | 1483782 | 133044.51 |
| Feb | 23 | 2002 | 185497 | 14062.507 | 607645 | 57483.367 | 1510595 | 130160.97 |
| Mar | 2 | 2002 | 193976 | 14727.938 | 857227 | 93028.37 | 1571050 | 135725.74 |
| Mar | 9 | 2002 | 189515 | 14039.827 | 1895848 | 198535.73 | 1459754 | 127047.46 |
| Mar | 16 | 2002 | 179186 | 12909.456 | 731260 | 75779.323 | 1654645 | 147394.14 |
| Mar | 23 | 2002 | 210185 | 15743.095 | 676222 | 67654.44 | 1394973 | 120846.75 |
| Mar | 30 | 2002 | 189363 | 14630.868 | 572822 | 52299.626 | 1627525 | 138680.49 |
| April | 6 | 2002 | 212113 | 17049.463 | 654096 | 62010.295 | 1249398 | 107884.22 |
| April | 13 | 2002 | 235567 | 17928.54 | 1723225 | 174432.33 | 1309309 | 112701.46 |
| April | 20 | 2002 | 240321 | 18249.689 | 755600 | 80953.538 | 1327435 | 115395.84 |
| April | 27 | 2002 | 246546 | 19178.208 | 1735611 | 184143.46 | 1449140 | 122268.79 |
| May | 4 | 2002 | 646375 | 132720.18 | 626418 | 57683.405 | 1421352 | 123591.48 |
| May | 11 | 2002 | 392320 | 49934.556 | 769082 | 73876.018 | 1383188 | 120717.02 |
| May | 18 | 2002 | 296058 | 23868.886 | 705916 | 66420.194 | 1320107 | 114984.88 |
| May | 25 | 2002 | 275428 | 22069.454 | 1811822 | 190403.59 | 1230436 | 107217.89 |
| June | 1 | 2002 | 281573 | 21838.118 | 989538 | 107756.76 | 1246185 | 107681.01 |
| June | 8 | 2002 | 286550 | 22883.213 | 1804313 | 183582.35 | 1778001 | 174520.79 |
| June | 15 | 2002 | 291854 | 23414.832 | 723277 | 67740.624 | 1387744 | 125031.21 |
| June | 22 | 2002 | 304584 | 24005.419 | 882766 | 95036.911 | 1306635 | 119722.73 |
| June | 29 | 2002 | 356195 | 27988.934 | 759439 | 70389.648 | 1395592 | 125425.84 |
| July | 6 | 2002 | 332396 | 25580.318 | 2062671 | 210412.79 | 1428487 | 123688.56 |
| July | 13 | 2002 | 298611 | 22287.182 | 855169 | 87177.384 | 1282694 | 112378.04 |
| July | 20 | 2002 | 300243 | 22253.162 | 877300 | 89718.905 | 1263946 | 110975.96 |
| July | 27 | 2002 | 264759 | 19587.355 | 783883 | 75106.181 | 1259794 | 110249.75 |
| Aug | 3 | 2002 | 275414 | 20023.718 | 759125 | 71419.774 | 1521464 | 135947.1 |
| Aug | 10 | 2002 | 245511 | 18066.888 | 836844 | 84343.291 | 1239684 | 108747.88 |
| Aug | 17 | 2002 | 264442 | 19644.962 | 798147 | 81127.721 | 1408108 | 122841.68 |
| Aug | 24 | 2002 | 233260 | 18301.399 | 710010 | 68105.318 | 1232521 | 107425.18 |
| Aug | 31 | 2002 | 424726 | 50440.32 | 1668914 | 170742.75 | 1401207 | 124060.05 |
| Sep | 7 | 2002 | 366144 | 39805.668 | 783951 | 73759.442 | 1311416 | 113805.06 |
| Sep | 14 | 2002 | 280348 | 28059.242 | 776239 | 77774.256 | 1259679 | 110499.23 |
| Sep | 21 | 2002 | 247434 | 24162.818 | 633575 | 59143.09 | 1329417 | 117450.19 |
| Sep | 28 | 2002 | 346226 | 41471.287 | 753159 | 78477.336 | 1476385 | 136666.96 |
| Oct | 5 | 2002 | 262493 | 27340.286 | 742007 | 77758.834 | 2046120 | 200980.18 |
| Oct | 12 | 2002 | 192974 | 18711 | 503795 | 46301.674 | 1441362 | 134990.91 |
| Oct | 19 | 2002 | 194173 | 19465.79 | 588856 | 64022.011 | 1337031 | 120453.48 |
| Oct | 26 | 2002 | 215188 | 20607.955 | 2169649 | 229676.28 | 1330731 | 117409.37 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | fcb11 | fcb12 | ufcb11 | ufcb12 | wngs11 | wngs12 |
| Nov | 2 | 2002 | 292884 | 33372.2592 | 601373 | 57877.092 | 1440874 | 129614.39 |
| Nov | 9 | 2002 | 214532 | 21018.9168 | 639250 | 60692.587 | 1445229 | 130049.39 |
| Nov | 16 | 2002 | 331299 | 61054.56 | 715533 | 76147.193 | 1538793 | 140682.23 |
| Nov | 23 | 2002 | 280631 | 48220.8552 | 545438 | 50681.182 | 2255015 | 209486.09 |
| Nov | 30 | 2002 | 206791 | 20279.0952 | 1202286 | 125301.56 | 1829788 | 159847.73 |
| Dec | 7 | 2002 | 171047 | 16546.8744 | 580325 | 55385.467 | 1669899 | 152610.54 |
| Dec | 14 | 2002 | 259369 | 45501.0696 | 469454 | 44228.268 | 1750572 | 165170.73 |
| Dec | 21 | 2002 | 129180 | 10953.0792 | 498866 | 46728.965 | 2051984 | 191494.5 |
| Dec | 28 | 2002 | 96186 | 7950.2472 | 317615 | 29340.662 | 2164169 | 208914.55 |
| Jan | 4 | 2003 | 165403 | 13359.8808 | 744780 | 77597.352 | 2583704 | 246116.56 |
| Jan | 11 | 2003 | 246885 | 19799.64 | 1881594 | 243187.21 | 1576517 | 143502.71 |
| Jan | 18 | 2003 | 307261 | 31252.5864 | 839049 | 86933.801 | 1815681 | 185180.39 |
| Jan | 25 | 2003 | 185376 | 14673.96 | 700783 | 66727.735 | 2162076 | 211109.07 |
| Feb | 1 | 2003 | 313373 | 34532.568 | 820960 | 83467.843 | 2113838 | 196066.79 |
| Feb | 8 | 2003 | 200453 | 16793.6328 | 686495 | 67770.108 | 1497807 | 136625.68 |
| Feb | 15 | 2003 | 161281 | 13280.0472 | 606714 | 57819.938 | 1715527 | 164604.18 |
| Feb | 22 | 2003 | 189840 | 16003.9152 | 2234848 | 239792.46 | 1646742 | 151580.42 |
| Mar | 1 | 2003 | 181429 | 15110.7768 | 792420 | 78763.104 | 1601007 | 145466.34 |
| Mar | 8 | 2003 | 167067 | 13048.2576 | 858339 | 87754.363 | 1627566 | 146181.67 |
| Mar | 15 | 2003 | 174035 | 13300.9128 | 886351 | 95009.695 | 1579888 | 141934.62 |
| Mar | 22 | 2003 | 205135 | 15958.5552 | 831254 | 83911.01 | 1657698 | 156135.02 |
| Mar | 29 | 2003 | 273751 | 26182.2456 | 650378 | 61267.298 | 2450613 | 253133.29 |
| April | 5 | 2003 | 246242 | 21401.3016 | 2036615 | 271073.17 | 1758775 | 163883.41 |
| April | 12 | 2003 | 195684 | 14716.5984 | 817225 | 86056.085 | 1623631 | 156934.26 |
| April | 19 | 2003 | 186857 | 14088.3624 | 656982 | 60516.59 | 1845017 | 168137.73 |
| April | 26 | 2003 | 164410 | 12164.1912 | 646501 | 64340.892 | 1487531 | 133141.13 |
| May | 3 | 2003 | 312301 | 28999.1016 | 788966 | 74257.042 | 1658286 | 154849.51 |
| May | 10 | 2003 | 246645 | 19272.1032 | 983588 | 96350.537 | 1443746 | 132455.74 |
| May | 17 | 2003 | 222053 | 16771.86 | 780961 | 72761.522 | 1519730 | 142662.64 |
| May | 24 | 2003 | 232903 | 17678.1528 | 2082019 | 271275.03 | 1522937 | 142792.37 |
| May | 31 | 2003 | 334399 | 33870.7656 | 844682 | 79386.35 | 1664914 | 163084.17 |
| June | 7 | 2003 | 374535 | 38048.4216 | 944248 | 95789.434 | 1456218 | 138268.62 |
| June | 14 | 2003 | 238401 | 19307.0304 | 785566 | 72780.12 | 2323337 | 242959.95 |
| June | 21 | 2003 | 291590 | 26900.748 | 1167022 | 132232.11 | 1419058 | 131934.1 |
| June | 28 | 2003 | 305755 | 24879.0528 | 887328 | 85261.378 | 1399713 | 129934.63 |
| July | 5 | 2003 | 368211 | 32343.4944 | 2522212 | 261599.28 | 1394143 | 126594.77 |
| July | 12 | 2003 | 488642 | 39386.088 | 936074 | 91213.063 | 1644508 | 151076.02 |
| July | 19 | 2003 | 367706 | 33057.0072 | 880178 | 86003.921 | 1506680 | 138012.79 |
| July | 26 | 2003 | 341736 | 30000.1968 | 976369 | 101745.66 | 1527384 | 143014.18 |
| Aug | 2 | 2003 | 264242 | 20212.416 | 785221 | 69824.462 | 1364191 | 124049.62 |
| Aug | 9 | 2003 | 304838 | 26756.5032 | 2128606 | 220916.81 | 1450451 | 135893.57 |
| Aug | 16 | 2003 | 270055 | 21069.2664 | 997800 | 107310.42 | 1444388 | 143771.24 |
| Aug | 23 | 2003 | 315636 | 24742.5192 | 861942 | 78749.496 | 1440116 | 138385.2 |
| Aug | 30 | 2003 | 379249 | 35850.7296 | 835355 | 74384.05 | 1752224 | 166149.14 |
| Sep | 6 | 2003 | 300054 | 23751.8568 | 2153625 | 218394.79 | 1354437 | 123670.86 |
| Sep | 13 | 2003 | 213092 | 16259.7456 | 717454 | 63600.163 | 1434161 | 130654.04 |
| Sep | 20 | 2003 | 204949 | 16264.2816 | 836183 | 83026.49 | 1492492 | 140583.34 |
| Sep | 27 | 2003 | 200823 | 15424.668 | 681669 | 63018.194 | 1513505 | 142509.78 |
| Oct | 4 | 2003 | 182291 | 14285.2248 | 995253 | 112642.49 | 1581163 | 157069.89 |
| Oct | 11 | 2003 | 178611 | 13910.0976 | 619436 | 56660.99 | 1440845 | 135405.04 |
| Oct | 18 | 2003 | 167600 | 13430.1888 | 646984 | 64813.543 | 1554882 | 144670.28 |
| Oct | 25 | 2003 | 183002 | 14392.728 | 716737 | 66221.064 | 2570222 | 273496.76 |
| Nov | 1 | 2003 | 217703 | 21145.9248 | 667348 | 61429.687 | 1838148 | 176779.71 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | sc11 | sc12 | bugu11 | bugu12 | bugb11 | bugb12 |
| Nov | 11 | 2000 | 226820 | 16834.4568 | 100955 | 17014.0824 | 242643 | 31938.883 |
| Nov | 18 | 2000 | 234442 | 17957.5704 | 100148 | 16814.952 | 269582 | 34317.108 |
| Nov | 25 | 2000 | 243377 | 22783.8744 | 82561 | 15156.5904 | 240393 | 30461.962 |
| Dec | 2 | 2000 | 272835 | 23232.0312 | 89327 | 15289.9488 | 227278 | 29951.208 |
| Dec | 9 | 2000 | 243105 | 20014.6464 | 68003 | 12715.3152 | 253272 | 33857.611 |
| Dec | 16 | 2000 | 256814 | 23611.6944 | 66697 | 12794.2416 | 212900 | 27452.326 |
| Dec | 23 | 2000 | 287628 | 28251.5688 | 61316 | 11382.6384 | 203721 | 26432.633 |
| Dec | 30 | 2000 | 180313 | 18823.4928 | 40775 | 7383.2472 | 156382 | 20272.291 |
| Jan | 6 | 2001 | 244204 | 21615.4008 | 66541 | 11406.6792 | 230384 | 29748.449 |
| Jan | 13 | 2001 | 245980 | 19414.5336 | 98529 | 15619.716 | 275663 | 36346.061 |
| Jan | 20 | 2001 | 289422 | 22327.0992 | 101791 | 18555.8688 | 298048 | 38615.875 |
| Jan | 27 | 2001 | 226571 | 19279.3608 | 76684 | 14061.1464 | 259437 | 33279.725 |
| Feb | 3 | 2001 | 264374 | 21786.8616 | 135139 | 23570.8704 | 288152 | 37524.06 |
| Feb | 10 | 2001 | 240401 | 18641.5992 | 84267 | 15709.0752 | 282168 | 36240.372 |
| Feb | 17 | 2001 | 241546 | 18051.012 | 93792 | 16005.276 | 364326 | 49592.542 |
| Feb | 24 | 2001 | 239790 | 18109.0728 | 96480 | 17050.3704 | 313960 | 41721.674 |
| Mar | 3 | 2001 | 225005 | 16768.2312 | 95216 | 19226.2896 | 267757 | 35004.766 |
| Mar | 10 | 2001 | 223839 | 16576.812 | 91106 | 17969.8176 | 238223 | 30958.2 |
| Mar | 17 | 2001 | 232228 | 17357.004 | 118648 | 22170.6072 | 245667 | 31711.63 |
| Mar | 24 | 2001 | 221291 | 16311.0024 | 99374 | 18568.5696 | 251343 | 32243.702 |
| Mar | 31 | 2001 | 279993 | 20446.02 | 114015 | 21443.4864 | 288245 | 37472.35 |
| April | 7 | 2001 | 241180 | 18107.712 | 98302 | 18957.7584 | 246575 | 31331.513 |
| April | 14 | 2001 | 200760 | 15556.212 | 108060 | 20124.8712 | 228051 | 29085.286 |
| April | 21 | 2001 | 176560 | 13049.1648 | 125443 | 22286.7288 | 302922 | 37624.306 |
| April | 28 | 2001 | 191393 | 14494.788 | 146420 | 26203.1112 | 287295 | 35917.409 |
| May | 5 | 2001 | 213092 | 17797.9032 | 183125 | 30192.9768 | 344615 | 43823.203 |
| May | 12 | 2001 | 200630 | 15018.2424 | 200245 | 32136.1992 | 321134 | 40667.962 |
| May | 19 | 2001 | 161383 | 12179.16 | 213680 | 34698.132 | 303579 | 38233.037 |
| May | 26 | 2001 | 156753 | 12210.4584 | 186812 | 31124.2176 | 299471 | 36949.349 |
| June | 2 | 2001 | 221393 | 17698.5648 | 211746 | 39128.4432 | 381283 | 47926.015 |
| June | 9 | 2001 | 169346 | 13648.824 | 190154 | 32222.8368 | 324213 | 42867.014 |
| June | 16 | 2001 | 148859 | 11858.0112 | 220037 | 36199.0944 | 365126 | 43741.555 |
| June | 23 | 2001 | 146229 | 12258.0864 | 212783 | 34611.0408 | 326518 | 40160.383 |
| June | 30 | 2001 | 161425 | 14150.5056 | 234282 | 37937.7432 | 375348 | 45755.993 |
| July | 7 | 2001 | 147907 | 12362.868 | 187764 | 32272.7328 | 333979 | 40461.574 |
| July | 14 | 2001 | 158465 | 13286.8512 | 179260 | 29185.0776 | 361667 | 42330.406 |
| July | 21 | 2001 | 164223 | 13760.4096 | 188174 | 30717.3384 | 323799 | 38703.874 |
| July | 28 | 2001 | 139409 | 11952.36 | 202047 | 32865.1344 | 360909 | 43962.005 |
| Aug | 4 | 2001 | 155936 | 13336.7472 | 183379 | 29494.8864 | 315931 | 38306.52 |
| Aug | 11 | 2001 | 135638 | 11760.0336 | 175230 | 27379.296 | 309965 | 36913.968 |
| Aug | 18 | 2001 | 162175 | 13691.4624 | 145854 | 24900.8256 | 284198 | 33842.189 |
| Aug | 25 | 2001 | 156998 | 13105.4112 | 155152 | 25630.2144 | 301850 | 35934.192 |
| Sep | 1 | 2001 | 232156 | 18629.8056 | 172749 | 31889.4408 | 297846 | 36280.742 |
| Sep | 8 | 2001 | 215308 | 17324.3448 | 152710 | 25898.7456 | 296944 | 36096.581 |
| Sep | 15 | 2001 | 251980 | 20499.0912 | 124710 | 22939.0056 | 292726 | 34602.876 |
| Sep | 22 | 2001 | 233994 | 18830.7504 | 124028 | 23193.9288 | 291419 | 34262.676 |
| Sep | 29 | 2001 | 213633 | 17516.6712 | 112314 | 20699.5824 | 251349 | 29063.059 |
| Oct | 6 | 2001 | 239314 | 20516.328 | 101494 | 19134.2088 | 252837 | 29687.213 |
| Oct | 13 | 2001 | 176876 | 10411.4808 | 80648 | 15652.3752 | 313326 | 36069.818 |
| Oct | 20 | 2001 | 221009 | 13066.8552 | 105740 | 19057.0968 | 303658 | 36518.882 |
| Oct | 27 | 2001 | 205627 | 11893.392 | 101123 | 19663.56 | 258212 | 29977.063 |
| Nov | 3 | 2001 | 237115 | 13834.8 | 104575 | 21109.1832 | 296578 | 35370.367 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | sc11 | sc12 | bugu11 | bugu12 | bugb11 | bugb12 |
| Nov | 10 | 2001 | 257571 | 15630.602 | 100053 | 18409.356 | 275865 | 32479.121 |
| Nov | 17 | 2001 | 216505 | 12648.636 | 89849 | 16759.159 | 251133 | 29026.771 |
| Nov | 24 | 2001 | 212871 | 12717.13 | 91049 | 17712.173 | 342524 | 43825.018 |
| Dec | 1 | 2001 | 240406 | 14681.218 | 88998 | 17595.144 | 297312 | 34582.918 |
| Dec | 8 | 2001 | 212301 | 12532.514 | 82817 | 16016.616 | 245330 | 28618.531 |
| Dec | 15 | 2001 | 224831 | 13651.092 | 76924 | 14912.1 | 228253 | 26427.19 |
| Dec | 22 | 2001 | 212304 | 12419.114 | 78229 | 14919.811 | 211954 | 24513.905 |
| Dec | 29 | 2001 | 141233 | 8302.2408 | 50288 | 9356.8608 | 172631 | 19907.143 |
| Jan | 5 | 2002 | 253609 | 15484.09 | 97008 | 16642.13 | 238665 | 27414.677 |
| Jan | 12 | 2002 | 252429 | 15222.816 | 126816 | 20915.95 | 292402 | 35631.641 |
| Jan | 19 | 2002 | 229170 | 13568.537 | 104239 | 20382.062 | 284471 | 33594.523 |
| Jan | 26 | 2002 | 224285 | 13292.748 | 107091 | 19111.982 | 307181 | 36133.322 |
| Feb | 2 | 2002 | 270911 | 16699.738 | 133185 | 24638.191 | 325986 | 38221.697 |
| Feb | 9 | 2002 | 236109 | 14280.689 | 95107 | 18373.068 | 293959 | 34190.554 |
| Feb | 16 | 2002 | 227172 | 13608 | 100956 | 21532.846 | 277449 | 32107.169 |
| Feb | 23 | 2002 | 194284 | 11154.478 | 109660 | 20048.213 | 402178 | 48028.075 |
| Mar | 2 | 2002 | 206022 | 12010.874 | 99818 | 18569.477 | 423790 | 51409.21 |
| Mar | 9 | 2002 | 246263 | 14629.961 | 99757 | 19052.107 | 297221 | 33788.664 |
| Mar | 16 | 2002 | 193834 | 11028.83 | 149562 | 28557.295 | 282371 | 32344.855 |
| Mar | 23 | 2002 | 210216 | 12080.275 | 102308 | 21462.084 | 294024 | 34191.007 |
| Mar | 30 | 2002 | 206800 | 11848.032 | 104582 | 19525.212 | 266433 | 30733.214 |
| April | 6 | 2002 | 197018 | 11408.494 | 105092 | 19769.702 | 370672 | 47497.817 |
| April | 13 | 2002 | 228745 | 13452.869 | 122824 | 21821.789 | 349487 | 43106.969 |
| April | 20 | 2002 | 195219 | 11353.608 | 142452 | 24072.552 | 347656 | 39636.022 |
| April | 27 | 2002 | 207546 | 12096.605 | 155232 | 26427.19 | 311346 | 36571.046 |
| May | 4 | 2002 | 196878 | 11274.682 | 153939 | 26862.646 | 409108 | 47388.046 |
| May | 11 | 2002 | 178634 | 10149.754 | 167276 | 29229.077 | 348694 | 40195.764 |
| May | 18 | 2002 | 181831 | 10513.087 | 166069 | 29711.707 | 344413 | 40172.177 |
| May | 25 | 2002 | 162768 | 9369.5616 | 150010 | 26169.545 | 367703 | 43781.472 |
| June | 1 | 2002 | 148832 | 8399.7648 | 220384 | 37400.227 | 506202 | 60672.629 |
| June | 8 | 2002 | 181696 | 10919.966 | 184560 | 30561.3 | 481689 | 55527.444 |
| June | 15 | 2002 | 143808 | 8133.5016 | 185410 | 31388.213 | 474986 | 54404.33 |
| June | 22 | 2002 | 156083 | 9211.2552 | 203458 | 32274.094 | 400567 | 46405.548 |
| June | 29 | 2002 | 124414 | 7001.316 | 227549 | 36405.936 | 480348 | 55269.346 |
| July | 6 | 2002 | 118592 | 6658.3944 | 229157 | 36519.79 | 503944 | 59915.57 |
| July | 13 | 2002 | 121547 | 6925.5648 | 235719 | 38640.823 | 425454 | 49273.207 |
| July | 20 | 2002 | 126022 | 7139.664 | 216716 | 33548.256 | 393485 | 45316.001 |
| July | 27 | 2002 | 143266 | 8406.5688 | 191715 | 30576.269 | 383857 | 43024.414 |
| Aug | 3 | 2002 | 130989 | 7476.2352 | 245518 | 37035.533 | 401467 | 46835.561 |
| Aug | 10 | 2002 | 128044 | 7268.0328 | 192131 | 29536.618 | 448812 | 55423.116 |
| Aug | 17 | 2002 | 129833 | 7481.6784 | 179060 | 28823.558 | 364517 | 42743.182 |
| Aug | 24 | 2002 | 147167 | 8388.4248 | 164305 | 27062.683 | 322490 | 36633.19 |
| Aug | 31 | 2002 | 182000 | 10631.477 | 208421 | 33352.754 | 379941 | 42562.195 |
| Sep | 7 | 2002 | 192683 | 11251.094 | 144589 | 24335.64 | 329276 | 37923.228 |
| Sep | 14 | 2002 | 230084 | 14882.162 | 180954 | 30273.718 | 322763 | 38657.606 |
| Sep | 21 | 2002 | 187028 | 10754.856 | 123971 | 21982.363 | 276072 | 31544.705 |
| Sep | 28 | 2002 | 203399 | 12038.09 | 116571 | 20502.266 | 286115 | 32404.277 |
| Oct | 5 | 2002 | 214117 | 12426.372 | 133118 | 24042.614 | 344454 | 39733.092 |
| Oct | 12 | 2002 | 214890 | 13388.004 | 92981 | 16165.85 | 270357 | 30015.166 |
| Oct | 19 | 2002 | 159884 | 8874.2304 | 94731 | 16791.818 | 330722 | 41053.522 |
| Oct | 26 | 2002 | 186204 | 10447.769 | 106815 | 20520.864 | 260480 | 29737.109 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YR | sc11 | sc12 | bugu11 | bugu12 | bugb11 | bugb12 |
| Nov | 2 | 2002 | 255363 | 16814.0448 | 137212 | 25968.146 | 311780 | 36170.518 |
| Nov | 9 | 2002 | 556371 | 30850.6968 | 97012 | 17865.036 | 286371 | 32149.807 |
| Nov | 16 | 2002 | 212054 | 12213.18 | 96130 | 17176.018 | 263067 | 29836.447 |
| Nov | 23 | 2002 | 204010 | 11694.2616 | 113944 | 22136.134 | 305984 | 37909.62 |
| Nov | 30 | 2002 | 217753 | 12668.5944 | 104620 | 19498.45 | 295004 | 33023.894 |
| Dec | 7 | 2002 | 229235 | 13519.0944 | 94345 | 17156.513 | 352199 | 42393.456 |
| Dec | 14 | 2002 | 204363 | 11839.4136 | 82352 | 15438.276 | 361082 | 45278.806 |
| Dec | 21 | 2002 | 200779 | 11560.9032 | 77348 | 14161.392 | 240112 | 27773.928 |
| Dec | 28 | 2002 | 141176 | 8140.7592 | 49923 | 9223.956 | 156074 | 17254.944 |
| Jan | 4 | 2003 | 200635 | 11715.1272 | 86937 | 15131.189 | 246533 | 27833.803 |
| Jan | 11 | 2003 | 234646 | 13612.0824 | 123481 | 22022.734 | 357345 | 43589.599 |
| Jan | 18 | 2003 | 252903 | 15315.3504 | 107017 | 19449.007 | 301005 | 33628.997 |
| Jan | 25 | 2003 | 257224 | 16047.4608 | 97943 | 17543.434 | 330722 | 38414.477 |
| Feb | 1 | 2003 | 239491 | 14797.7928 | 134987 | 23090.054 | 326240 | 38430.806 |
| Feb | 8 | 2003 | 234176 | 14318.7912 | 103191 | 18526.838 | 328446 | 37798.942 |
| Feb | 15 | 2003 | 234139 | 13847.0472 | 97992 | 18364.903 | 302456 | 34303.954 |
| Feb | 22 | 2003 | 225182 | 13118.112 | 116237 | 19683.065 | 570261 | 75442.298 |
| Mar | 1 | 2003 | 203853 | 11682.0144 | 107156 | 19171.404 | 394466 | 57496.068 |
| Mar | 8 | 2003 | 226540 | 13145.328 | 107032 | 18277.812 | 331025 | 39450.953 |
| Mar | 15 | 2003 | 213581 | 12309.3432 | 119787 | 19611.85 | 362246 | 41992.474 |
| Mar | 22 | 2003 | 215141 | 12525.2568 | 114976 | 19235.362 | 360714 | 40923.792 |
| Mar | 29 | 2003 | 224666 | 13217.904 | 130655 | 22400.129 | 330237 | 37335.362 |
| April | 5 | 2003 | 223999 | 13104.9576 | 131637 | 22482.684 | 477626 | 59576.731 |
| April | 12 | 2003 | 203575 | 11713.3128 | 150279 | 26169.998 | 419209 | 51831.511 |
| April | 19 | 2003 | 191139 | 11043.3456 | 138478 | 23089.601 | 328216 | 37208.808 |
| April | 26 | 2003 | 156260 | 8935.4664 | 133437 | 21471.156 | 409555 | 52231.198 |
| May | 3 | 2003 | 173039 | 9901.6344 | 182078 | 28274.702 | 457782 | 52636.198 |
| May | 10 | 2003 | 180671 | 10462.7376 | 196397 | 29620.534 | 592440 | 76593.535 |
| May | 17 | 2003 | 159850 | 9104.2056 | 227895 | 34822.872 | 415005 | 48292.978 |
| May | 24 | 2003 | 371444 | 18972.7272 | 220830 | 32794.373 | 431077 | 48771.979 |
| May | 31 | 2003 | 167679 | 9705.2256 | 214605 | 33705.655 | 486561 | 56133.907 |
| June | 7 | 2003 | 154029 | 8803.9224 | 233922 | 35334.986 | 421425 | 48450.83 |
| June | 14 | 2003 | 146865 | 8343.5184 | 207196 | 33033.874 | 449175 | 50446.217 |
| June | 21 | 2003 | 145311 | 8382.528 | 218442 | 32292.238 | 503653 | 67205.376 |
| June | 28 | 2003 | 121294 | 7246.7136 | 262395 | 37624.759 | 443245 | 50616.77 |
| July | 5 | 2003 | 124722 | 7109.2728 | 247913 | 36800.114 | 451320 | 51835.14 |
| July | 12 | 2003 | 124643 | 7050.7584 | 211612 | 30694.658 | 418275 | 47952.324 |
| July | 19 | 2003 | 131142 | 7502.9976 | 216826 | 31204.958 | 401882 | 46004.566 |
| July | 26 | 2003 | 125115 | 7082.0568 | 183472 | 26821.368 | 414231 | 54936.857 |
| Aug | 2 | 2003 | 113367 | 6422.0688 | 211088 | 31179.557 | 416964 | 47817.605 |
| Aug | 9 | 2003 | 121658 | 6797.196 | 182536 | 26287.481 | 368005 | 42093.626 |
| Aug | 16 | 2003 | 106030 | 5867.316 | 154197 | 22152.917 | 440392 | 53497.584 |
| Aug | 23 | 2003 | 126720 | 7284.3624 | 155697 | 23283.288 | 486484 | 58477.658 |
| Aug | 30 | 2003 | 167883 | 10005.9624 | 162881 | 24577.862 | 630990 | 83480.544 |
| Sep | 6 | 2003 | 181015 | 10637.8272 | 145833 | 22426.438 | 362691 | 42261.912 |
| Sep | 13 | 2003 | 170255 | 9982.8288 | 126770 | 20482.308 | 367750 | 44300.39 |
| Sep | 20 | 2003 | 173015 | 9954.252 | 126071 | 20750.839 | 349173 | 39969.418 |
| Sep | 27 | 2003 | 174318 | 10096.2288 | 118239 | 19137.838 | 304076 | 34962.127 |
| Oct | 4 | 2003 | 171374 | 9522.8784 | 105316 | 17360.633 | 377466 | 45785.477 |
| Oct | 11 | 2003 | 162883 | 9182.6784 | 101852 | 16266.55 | 288482 | 32865.134 |
| Oct | 18 | 2003 | 144910 | 8196.552 | 89325 | 14114.218 | 298972 | 34277.191 |
| Oct | 25 | 2003 | 205983 | 11482.4304 | 98919 | 15770.311 | 354607 | 41244.034 |
| Nov | 1 | 2003 | 412425 | 21148.6464 | 104468 | 17027.237 | 301506 | 35327.275 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|
| MONTH | DAY | YR | part11 | part12 | mix11 | mix12 |
| Nov | 11 | 2000 | 48833 | 5056.2792 | 283861 | 38253.4488 |
| Nov | 18 | 2000 | 62939 | 6395.76 | 258146 | 42895.5912 |
| Nov | 25 | 2000 | 57305 | 6105.456 | 260325 | 41796.972 |
| Dec | 2 | 2000 | 67039 | 7185.9312 | 274943 | 44710.8984 |
| Dec | 9 | 2000 | 60718 | 6423.8832 | 645205 | 136564.445 |
| Dec | 16 | 2000 | 57893 | 6185.2896 | 232075 | 38961.972 |
| Dec | 23 | 2000 | 78595 | 8491.392 | 230912 | 34465.4352 |
| Dec | 30 | 2000 | 50428 | 5417.7984 | 169472 | 26041.176 |
| Jan | 6 | 2001 | 50295 | 5404.644 | 291962 | 51215.5224 |
| Jan | 13 | 2001 | 47447 | 4896.612 | 302082 | 56404.7064 |
| Jan | 20 | 2001 | 43229 | 4482.0216 | 289978 | 49888.7424 |
| Jan | 27 | 2001 | 38823 | 3989.8656 | 410887 | 67266.1584 |
| Feb | 3 | 2001 | 48075 | 4942.8792 | 265966 | 40048.7976 |
| Feb | 10 | 2001 | 49546 | 5301.2232 | 265502 | 40995.4608 |
| Feb | 17 | 2001 | 49168 | 5051.2896 | 273089 | 41458.5864 |
| Feb | 24 | 2001 | 60420 | 6210.6912 | 259944 | 29887.704 |
| Mar | 3 | 2001 | 55939 | 5836.9248 | 451503 | 72779.6664 |
| Mar | 10 | 2001 | 47639 | 4813.1496 | 266884 | 40657.5288 |
| Mar | 17 | 2001 | 46981 | 5031.3312 | 270511 | 42007.4424 |
| Mar | 24 | 2001 | 49538 | 5280.8112 | 300978 | 41757.0552 |
| Mar | 31 | 2001 | 48547 | 4991.4144 | 263964 | 39792.06 |
| April | 7 | 2001 | 36955 | 3806.1576 | 279237 | 42519.1032 |
| April | 14 | 2001 | 42283 | 4432.5792 | 254856 | 42010.164 |
| April | 21 | 2001 | 36874 | 3765.7872 | 449732 | 76158.9864 |
| April | 28 | 2001 | 41876 | 4252.0464 | 435334 | 64377.18 |
| May | 5 | 2001 | 45905 | 4709.7288 | 430159 | 67590.0288 |
| May | 12 | 2001 | 54398 | 5564.7648 | 378921 | 57504.6864 |
| May | 19 | 2001 | 46401 | 4829.4792 | 476681 | 68320.7784 |
| May | 26 | 2001 | 38786 | 3868.3008 | 373841 | 55999.188 |
| June | 2 | 2001 | 61050 | 6579.0144 | 369234 | 64012.032 |
| June | 9 | 2001 | 48539 | 5015.0016 | 491291 | 80524.8864 |
| June | 16 | 2001 | 42096 | 4360.4568 | 470803 | 63877.7664 |
| June | 23 | 2001 | 39874 | 4043.844 | 330707 | 41741.6328 |
| June | 30 | 2001 | 49315 | 5717.628 | 460875 | 67457.124 |
| July | 7 | 2001 | 51723 | 5403.7368 | 497553 | 64085.0616 |
| July | 14 | 2001 | 43433 | 4530.1032 | 358118 | 45910.6704 |
| July | 21 | 2001 | 38037 | 3865.5792 | 552743 | 77113.8144 |
| July | 28 | 2001 | 44424 | 4810.8816 | 416702 | 59246.5104 |
| Aug | 4 | 2001 | 57421 | 5692.2264 | 425063 | 55502.9496 |
| Aug | 11 | 2001 | 56591 | 5889.5424 | 455484 | 85112.5968 |
| Aug | 18 | 2001 | 38819 | 3909.1248 | 418778 | 79639.9128 |
| Aug | 25 | 2001 | 40484 | 4056.0912 | 353665 | 46532.556 |
| Sep | 1 | 2001 | 44836 | 4432.1256 | 352305 | 45086.0256 |
| Sep | 8 | 2001 | 41102 | 4089.6576 | 457993 | 66513.1824 |
| Sep | 15 | 2001 | 49545 | 5085.3096 | 292209 | 36560.16 |
| Sep | 22 | 2001 | 48507 | 5037.228 | 305059 | 37745.4168 |
| Sep | 29 | 2001 | 43119 | 4425.3216 | 276427 | 39104.4024 |
| Oct | 6 | 2001 | 53399 | 5921.748 | 244115 | 34335.252 |
| Oct | 13 | 2001 | 35965 | 3582.5328 | 230205 | 32485.0176 |
| Oct | 20 | 2001 | 50074 | 4975.5384 | 251142 | 33038.8632 |
| Oct | 27 | 2001 | 51967 | 5238.1728 | 234606 | 29934.8784 |
| Nov | 3 | 2001 | 52000 | 5081.6808 | 283642 | 51849.6552 |

| Frozen | | | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|
| MONTH | DAY | YR | part11 | part12 | mix11 | mix12 |
| Nov | 2 | 2002 | 29349 | 2541.0672 | 325545 | 41259.456 |
| Nov | 9 | 2002 | 27121 | 2340.576 | 326775 | 37209.715 |
| Nov | 16 | 2002 | 25878 | 2258.0208 | 285111 | 34240.45 |
| Nov | 23 | 2002 | 20136 | 1770.8544 | 347274 | 37387.526 |
| Nov | 30 | 2002 | 30474 | 3040.0272 | 327836 | 41111.582 |
| Dec | 7 | 2002 | 23061 | 2087.9208 | 236965 | 27354.348 |
| Dec | 14 | 2002 | 18280 | 1630.692 | 224229 | 28090.994 |
| Dec | 21 | 2002 | 18189 | 1629.3312 | 200957 | 24056.676 |
| Dec | 28 | 2002 | 10520 | 947.5704 | 134560 | 16086.924 |
| Jan | 4 | 2003 | 14677 | 1332.6768 | 234576 | 32526.749 |
| Jan | 11 | 2003 | 22363 | 1972.2528 | 389876 | 47955.046 |
| Jan | 18 | 2003 | 16169 | 1428.3864 | 505673 | 62776.879 |
| Jan | 25 | 2003 | 20957 | 2203.1352 | 509859 | 64342.253 |
| Feb | 1 | 2003 | 20430 | 1847.5128 | 317947 | 40352.256 |
| Feb | 8 | 2003 | 16032 | 1422.036 | 406189 | 43341.026 |
| Feb | 15 | 2003 | 17325 | 1597.1256 | 397061 | 60299.316 |
| Feb | 22 | 2003 | 18276 | 1687.8456 | 324118 | 44100.353 |
| Mar | 1 | 2003 | 26053 | 2478.0168 | 312745 | 34148.822 |
| Mar | 8 | 2003 | 13080 | 1212.9264 | 369801 | 43105.608 |
| Mar | 15 | 2003 | 15783 | 1453.788 | 519447 | 68427.374 |
| Mar | 22 | 2003 | 14228 | 1475.1072 | 462421 | 57864.391 |
| Mar | 29 | 2003 | 13043 | 1266.4512 | 370550 | 37797.127 |
| April | 5 | 2003 | 14733 | 1358.532 | 344810 | 40387.183 |
| April | 12 | 2003 | 12006 | 1096.8048 | 332277 | 36699.415 |
| April | 19 | 2003 | 11370 | 1136.7216 | 357707 | 36057.118 |
| April | 26 | 2003 | 10697 | 977.9616 | 365364 | 39666.866 |
| May | 3 | 2003 | 10567 | 979.3224 | 762158 | 97360.704 |
| May | 10 | 2003 | 14964 | 1605.2904 | 460566 | 55758.326 |
| May | 17 | 2003 | 8965 | 833.2632 | 436189 | 46702.656 |
| May | 24 | 2003 | 9869 | 936.2304 | 829541 | 110472.01 |
| May | 31 | 2003 | 9705 | 971.1576 | 438438 | 50079.254 |
| June | 7 | 2003 | 7729 | 739.8216 | 636535 | 88078.687 |
| June | 14 | 2003 | 10966 | 1045.0944 | 490982 | 52133.155 |
| June | 21 | 2003 | 9029 | 827.82 | 596361 | 70561.109 |
| June | 28 | 2003 | 8037 | 790.6248 | 544757 | 60527.477 |
| July | 5 | 2003 | 7227 | 690.3792 | 856472 | 131700.04 |
| July | 12 | 2003 | 9365 | 856.8504 | 467288 | 52506.468 |
| July | 19 | 2003 | 17359 | 2202.6816 | 807606 | 108942.02 |
| July | 26 | 2003 | 7568 | 752.5224 | 405933 | 41100.242 |
| Aug | 2 | 2003 | 9503 | 882.252 | 422352 | 42978.146 |
| Aug | 9 | 2003 | 6944 | 645.9264 | 446742 | 45015.264 |
| Aug | 16 | 2003 | 6657 | 612.8136 | 400733 | 41253.106 |
| Aug | 23 | 2003 | 7319 | 671.328 | 604414 | 75251.786 |
| Aug | 30 | 2003 | 10016 | 938.4984 | 404052 | 41329.764 |
| Sep | 6 | 2003 | 12976 | 1456.5096 | 726969 | 111768.85 |
| Sep | 13 | 2003 | 9509 | 908.5608 | 361872 | 38301.077 |
| Sep | 20 | 2003 | 10530 | 1129.9176 | 358979 | 36278.474 |
| Sep | 27 | 2003 | 8631 | 835.9848 | 349350 | 38256.17 |
| Oct | 4 | 2003 | 9915 | 979.776 | 299972 | 29240.417 |
| Oct | 11 | 2003 | 10091 | 959.364 | 283839 | 27247.752 |
| Oct | 18 | 2003 | 6707 | 650.0088 | 323584 | 32695.034 |
| Oct | 25 | 2003 | 7771 | 756.1512 | 432048 | 52647.538 |
| Nov | 1 | 2003 | 7522 | 721.224 | 327297 | 34902.252 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | drum11 | drum12 | wing11 | wing12 | burg11 | burg12 |
| Nov | 11 | 2000 | 1091324.00 | 258245.00 | 950038.00 | 160336.00 | 15262.00 | 2104.00 |
| Nov | 18 | 2000 | 1145579.00 | 274682.00 | 1085331.00 | 189081.00 | 16643.00 | 2152.00 |
| Nov | 25 | 2000 | 1191150.00 | 296333.00 | 1053052.00 | 176794.00 | 17341.00 | 2518.00 |
| Dec | 2 | 2000 | 1163891.00 | 274759.00 | 999481.00 | 159619.00 | 17667.00 | 3387.00 |
| Dec | 9 | 2000 | 1100565.00 | 267406.00 | 1045495.00 | 167483.00 | 14586.00 | 3006.00 |
| Dec | 16 | 2000 | 1117980.00 | 260592.00 | 1038362.00 | 162680.00 | 15151.00 | 3221.00 |
| Dec | 23 | 2000 | 1072669.00 | 255080.00 | 1226769.00 | 213120.00 | 15838.00 | 3230.00 |
| Dec | 30 | 2000 | 752838.00 | 176611.00 | 842667.00 | 132555.00 | 9451.00 | 1893.00 |
| Jan | 6 | 2001 | 972059.00 | 230922.00 | 882382.00 | 148454.00 | 13842.00 | 2614.00 |
| Jan | 13 | 2001 | 1302835.00 | 319754.00 | 963594.00 | 155572.00 | 16082.00 | 3021.00 |
| Jan | 20 | 2001 | 1505960.00 | 368108.00 | 1078014.00 | 187299.00 | 16096.00 | 3126.00 |
| Jan | 27 | 2001 | 1236322.00 | 303463.00 | 1121343.00 | 185160.00 | 15104.00 | 2954.00 |
| Feb | 3 | 2001 | 1341300.00 | 335379.00 | 1113803.00 | 173203.00 | 17618.00 | 3223.00 |
| Feb | 10 | 2001 | 1407607.00 | 344291.00 | 1024597.00 | 162106.00 | 13243.00 | 2607.00 |
| Feb | 17 | 2001 | 1179055.00 | 294980.00 | 1056975.00 | 172807.00 | 16110.00 | 3071.00 |
| Feb | 24 | 2001 | 1358800.00 | 340963.00 | 1053758.00 | 168426.00 | 18134.00 | 3288.00 |
| Mar | 3 | 2001 | 1192160.00 | 288031.00 | 1086126.00 | 184682.00 | 20223.00 | 3514.00 |
| Mar | 10 | 2001 | 1223838.00 | 283583.00 | 1032615.00 | 165076.00 | 16008.00 | 2802.00 |
| Mar | 17 | 2001 | 1192789.00 | 286974.00 | 1002254.00 | 153491.00 | 15974.00 | 3065.00 |
| Mar | 24 | 2001 | 1330842.00 | 350956.00 | 1035918.00 | 162851.00 | 16268.00 | 3060.00 |
| Mar | 31 | 2001 | 1305799.00 | 308304.00 | 1110623.00 | 169486.00 | 17824.00 | 3053.00 |
| April | 7 | 2001 | 1326378.00 | 326975.00 | 1028197.00 | 159096.00 | 16497.00 | 2848.00 |
| April | 14 | 2001 | 1126251.00 | 274915.00 | 998205.00 | 154242.00 | 13801.00 | 2377.00 |
| April | 21 | 2001 | 1143756.00 | 298303.00 | 930307.00 | 139038.00 | 15590.00 | 2709.00 |
| April | 28 | 2001 | 1652536.00 | 438054.00 | 1054054.00 | 168012.00 | 17531.00 | 2963.00 |
| May | 5 | 2001 | 1612327.00 | 404724.00 | 1082019.00 | 167968.00 | 17045.00 | 2914.00 |
| May | 12 | 2001 | 1394110.00 | 350892.00 | 1036061.00 | 159677.00 | 12057.00 | 2748.00 |
| May | 19 | 2001 | 1451926.00 | 352249.00 | 1088232.00 | 171312.00 | 14705.00 | 2718.00 |
| May | 26 | 2001 | 1289924.00 | 323048.00 | 1025602.00 | 161572.00 | 15222.00 | 2757.00 |
| June | 2 | 2001 | 1565295.00 | 384203.00 | 1176557.00 | 186295.00 | 18237.00 | 3125.00 |
| June | 9 | 2001 | 1494891.00 | 364888.00 | 1072936.00 | 157421.00 | 15383.00 | 2761.00 |
| June | 16 | 2001 | 1327506.00 | 334684.00 | 1019758.00 | 156592.00 | 15485.00 | 2710.00 |
| June | 23 | 2001 | 1243637.00 | 303559.00 | 1016267.00 | 156722.00 | 16538.00 | 2865.00 |
| June | 30 | 2001 | 1602120.00 | 402257.00 | 1119475.00 | 172885.00 | 17788.00 | 3045.00 |
| July | 7 | 2001 | 1490232.00 | 393154.00 | 1029076.00 | 159204.00 | 15061.00 | 2461.00 |
| July | 14 | 2001 | 1454413.00 | 348152.00 | 1074729.00 | 150271.00 | 16235.00 | 2925.00 |
| July | 21 | 2001 | 1375731.00 | 350327.00 | 1083959.00 | 169212.00 | 18091.00 | 3174.00 |
| July | 28 | 2001 | 1430310.00 | 349371.00 | 1138447.00 | 177411.00 | 16521.00 | 2853.00 |
| Aug | 4 | 2001 | 1314753.00 | 327212.00 | 1071500.00 | 164191.00 | 20378.00 | 3654.00 |
| Aug | 11 | 2001 | 1249036.00 | 296989.00 | 1019159.00 | 151637.00 | 19346.00 | 3748.00 |
| Aug | 18 | 2001 | 1247482.00 | 305628.00 | 1050653.00 | 150902.00 | 19333.00 | 3622.00 |
| Aug | 25 | 2001 | 1300480.00 | 315501.00 | 1029093.00 | 156945.00 | 16936.00 | 3249.00 |
| Sep | 1 | 2001 | 1435846.00 | 343128.00 | 1182719.00 | 173723.00 | 17670.00 | 3279.00 |
| Sep | 8 | 2001 | 1399413.00 | 340523.00 | 1002954.00 | 144570.00 | 18812.00 | 3399.00 |
| Sep | 15 | 2001 | 1436285.00 | 359175.00 | 1019089.00 | 143119.00 | 17002.00 | 3139.00 |
| Sep | 22 | 2001 | 1573797.00 | 398586.00 | 1035059.00 | 145068.00 | 17049.00 | 3273.00 |
| Sep | 29 | 2001 | 1391266.00 | 348802.00 | 1010575.00 | 142623.00 | 17401.00 | 2913.00 |
| Oct | 6 | 2001 | 1223957.00 | 286565.00 | 1036756.00 | 147719.00 | 16469.00 | 3209.00 |
| Oct | 13 | 2001 | 1078325.00 | 249822.00 | 871456.00 | 122189.00 | 14515.00 | 2717.00 |
| Oct | 20 | 2001 | 1191510.00 | 278668.00 | 1046824.00 | 146981.00 | 19672.00 | 3596.00 |
| Oct | 27 | 2001 | 1316149.00 | 299213.00 | 1112016.00 | 154093.00 | 17684.00 | 3423.00 |
| Nov | 3 | 2001 | 1457210.00 | 352569.00 | 1112258.00 | 167434.00 | 21800.00 | 3953.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | drum11 | drum12 | wing11 | wing12 | burg11 | burg12 |
| Nov | 10 | 2001 | 1286230.00 | 296684.00 | 894581.00 | 133432.00 | 18734.00 | 3298.00 |
| Nov | 17 | 2001 | 1220662.00 | 293973.00 | 1022104.00 | 145573.00 | 18037.00 | 3319.00 |
| Nov | 24 | 2001 | 1303019.00 | 312638.00 | 1215539.00 | 174426.00 | 19833.00 | 3700.00 |
| Dec | 1 | 2001 | 1256813.00 | 286608.00 | 1270683.00 | 184860.00 | 21826.00 | 3681.00 |
| Dec | 8 | 2001 | 1300953.00 | 305765.00 | 1095263.00 | 156036.00 | 20182.00 | 3771.00 |
| Dec | 15 | 2001 | 1221312.00 | 289805.00 | 1154908.00 | 167362.00 | 16830.00 | 3042.00 |
| Dec | 22 | 2001 | 1084910.00 | 241846.00 | 1280283.00 | 177762.00 | 19838.00 | 3213.00 |
| Dec | 29 | 2001 | 721453.00 | 161426.00 | 851200.00 | 144717.00 | 11596.00 | 1945.00 |
| Jan | 5 | 2002 | 1022959.00 | 235005.00 | 1102054.00 | 151088.00 | 18203.00 | 2981.00 |
| Jan | 12 | 2002 | 1448416.00 | 359314.00 | 1070810.00 | 162556.00 | 19587.00 | 3420.00 |
| Jan | 19 | 2002 | 1402298.00 | 321797.00 | 1137034.00 | 159428.00 | 23198.00 | 4036.00 |
| Jan | 26 | 2002 | 1244911.00 | 297992.00 | 1020468.00 | 152526.00 | 18823.00 | 3566.00 |
| Feb | 2 | 2002 | 1555796.00 | 402628.00 | 1410285.00 | 242782.00 | 20968.00 | 3665.00 |
| Feb | 9 | 2002 | 1383450.00 | 332549.00 | 1233929.00 | 181128.00 | 19651.00 | 3636.00 |
| Feb | 16 | 2002 | 1309433.00 | 327606.00 | 1094482.00 | 165265.00 | 16458.00 | 3145.00 |
| Feb | 23 | 2002 | 1231569.00 | 294636.00 | 1080209.00 | 157929.00 | 16545.00 | 3224.00 |
| Mar | 2 | 2002 | 1842969.00 | 394543.00 | 1137355.00 | 164103.00 | 18367.00 | 3615.00 |
| Mar | 9 | 2002 | 1276853.00 | 288331.00 | 1192175.00 | 180859.00 | 17317.00 | 3008.00 |
| Mar | 16 | 2002 | 1327943.00 | 315926.00 | 1119686.00 | 154150.00 | 16113.00 | 3027.00 |
| Mar | 23 | 2002 | 1268419.00 | 302150.00 | 1079158.00 | 176815.00 | 15030.00 | 3073.00 |
| Mar | 30 | 2002 | 1147552.00 | 265475.00 | 1074815.00 | 161092.00 | 14441.00 | 2675.00 |
| April | 6 | 2002 | 1223408.00 | 303820.00 | 972645.00 | 153211.00 | 15822.00 | 3107.00 |
| April | 13 | 2002 | 1437001.00 | 358633.00 | 1098706.00 | 160155.00 | 17885.00 | 3391.00 |
| April | 20 | 2002 | 1310958.00 | 313410.00 | 1126552.00 | 168083.00 | 16961.00 | 3104.00 |
| April | 27 | 2002 | 1212839.00 | 287651.00 | 1143285.00 | 219219.00 | 20667.00 | 3834.00 |
| May | 4 | 2002 | 1367454.00 | 326243.00 | 1218876.00 | 197165.00 | 18972.00 | 3331.00 |
| May | 11 | 2002 | 1425670.00 | 338161.00 | 1111067.00 | 175943.00 | 18519.00 | 3269.00 |
| May | 18 | 2002 | 1410602.00 | 325683.00 | 1152451.00 | 171259.00 | 20629.00 | 3536.00 |
| May | 25 | 2002 | 1278434.00 | 308105.00 | 1075394.00 | 156559.00 | 19266.00 | 3192.00 |
| June | 1 | 2002 | 1537173.00 | 368290.00 | 1213125.00 | 195056.00 | 22823.00 | 3832.00 |
| June | 8 | 2002 | 1389533.00 | 328316.00 | 1123431.00 | 164172.00 | 20381.00 | 3046.00 |
| June | 15 | 2002 | 1381861.00 | 330110.00 | 1183528.00 | 194846.00 | 18837.00 | 3367.00 |
| June | 22 | 2002 | 1258573.00 | 290091.00 | 1170848.00 | 178567.00 | 21881.00 | 3773.00 |
| June | 29 | 2002 | 1432430.00 | 321707.00 | 1161640.00 | 183393.00 | 20806.00 | 3585.00 |
| July | 6 | 2002 | 1347730.00 | 330723.00 | 1040620.00 | 148192.00 | 19324.00 | 3323.00 |
| July | 13 | 2002 | 1427181.00 | 357123.00 | 1073921.00 | 154025.00 | 19208.00 | 3294.00 |
| July | 20 | 2002 | 1302506.00 | 323784.00 | 1101423.00 | 158782.00 | 19656.00 | 3456.00 |
| July | 27 | 2002 | 1481855.00 | 388338.00 | 1141531.00 | 163636.00 | 18162.00 | 3271.00 |
| Aug | 3 | 2002 | 1498782.00 | 354032.00 | 1247841.00 | 203148.00 | 19688.00 | 3257.00 |
| Aug | 10 | 2002 | 1850149.00 | 396391.00 | 1111529.00 | 168808.00 | 16310.00 | 2865.00 |
| Aug | 17 | 2002 | 1302791.00 | 329153.00 | 1087388.00 | 158494.00 | 16520.00 | 2993.00 |
| Aug | 24 | 2002 | 1372850.00 | 322509.00 | 1074428.00 | 155275.00 | 18474.00 | 3067.00 |
| Aug | 31 | 2002 | 1606700.00 | 397127.00 | 1251535.00 | 194218.00 | 16969.00 | 3375.00 |
| Sep | 7 | 2002 | 1913976.00 | 413555.00 | 1591441.00 | 238412.00 | 14290.00 | 2833.00 |
| Sep | 14 | 2002 | 1352805.00 | 336460.00 | 1108071.00 | 183063.00 | 15280.00 | 2165.00 |
| Sep | 21 | 2002 | 1391514.00 | 341000.00 | 1048797.00 | 158584.00 | 15819.00 | 2682.00 |
| Sep | 28 | 2002 | 1383952.00 | 330517.00 | 1046339.00 | 158086.00 | 16906.00 | 3233.00 |
| Oct | 5 | 2002 | 1457086.00 | 345210.00 | 1239471.00 | 195635.00 | 14107.00 | 2891.00 |
| Oct | 12 | 2002 | 1158723.00 | 260637.00 | 1037354.00 | 147774.00 | 14616.00 | 2721.00 |
| Oct | 19 | 2002 | 1059732.00 | 239429.00 | 933229.00 | 137125.00 | 13636.00 | 2438.00 |
| Oct | 26 | 2002 | 1487004.00 | 335313.00 | 1309931.00 | 204540.00 | 16249.00 | 3226.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | drum11 | drum12 | wing11 | wing12 | burg11 | burg12 |
| Nov | 2 | 2002 | 1743726.00 | 449199.00 | 1303067.00 | 197861.00 | 14562.00 | 2862.00 |
| Nov | 9 | 2002 | 1487277.00 | 343939.00 | 1189376.00 | 176052.00 | 14018.00 | 2643.00 |
| Nov | 16 | 2002 | 1253763.00 | 277890.00 | 1190149.00 | 188949.00 | 14121.00 | 2364.00 |
| Nov | 23 | 2002 | 1838211.00 | 385418.00 | 1839028.00 | 274464.00 | 15315.00 | 2824.00 |
| Nov | 30 | 2002 | 1359978.00 | 303625.00 | 1262758.00 | 177972.00 | 16770.00 | 2891.00 |
| Dec | 7 | 2002 | 1291128.00 | 284241.00 | 1220855.00 | 181755.00 | 14230.00 | 2606.00 |
| Dec | 14 | 2002 | 1341842.00 | 319513.00 | 1263054.00 | 193691.00 | 13922.00 | 2612.00 |
| Dec | 21 | 2002 | 1139642.00 | 247954.00 | 1347910.00 | 204725.00 | 12150.00 | 2494.00 |
| Dec | 28 | 2002 | 786668.00 | 165681.00 | 883569.00 | 131425.00 | 7369.00 | 1425.00 |
| Jan | 4 | 2003 | 1071737.00 | 228148.00 | 1110054.00 | 157296.00 | 16407.00 | 2634.00 |
| Jan | 11 | 2003 | 1413108.00 | 323568.00 | 1203438.00 | 184224.00 | 17169.00 | 2919.00 |
| Jan | 18 | 2003 | 1489678.00 | 370494.00 | 1207358.00 | 174745.00 | 18049.00 | 3244.00 |
| Jan | 25 | 2003 | 1296439.00 | 295702.00 | 1321927.00 | 211253.00 | 16703.00 | 2705.00 |
| Feb | 1 | 2003 | 1480619.00 | 349827.00 | 1268788.00 | 180506.00 | 16243.00 | 3124.00 |
| Feb | 8 | 2003 | 1572271.00 | 375503.00 | 1226481.00 | 186143.00 | 15542.00 | 2793.00 |
| Feb | 15 | 2003 | 1251286.00 | 281456.00 | 1214105.00 | 197178.00 | 13542.00 | 2548.00 |
| Feb | 22 | 2003 | 1446188.00 | 315617.00 | 1285750.00 | 204349.00 | 19430.00 | 3816.00 |
| Mar | 1 | 2003 | 1445579.00 | 338745.00 | 1240411.00 | 202213.00 | 18582.00 | 3436.00 |
| Mar | 8 | 2003 | 1899394.00 | 434912.00 | 1167859.00 | 185897.00 | 16052.00 | 2847.00 |
| Mar | 15 | 2003 | 1541553.00 | 390450.00 | 1186720.00 | 177435.00 | 15029.00 | 2661.00 |
| Mar | 22 | 2003 | 1460657.00 | 364892.00 | 1214464.00 | 172860.00 | 15624.00 | 2375.00 |
| Mar | 29 | 2003 | 1503332.00 | 324515.00 | 1381476.00 | 217204.00 | 14925.00 | 2357.00 |
| April | 5 | 2003 | 1651515.00 | 347329.00 | 1536850.00 | 266472.00 | 13562.00 | 2251.00 |
| April | 12 | 2003 | 1345840.00 | 288343.00 | 1235604.00 | 189732.00 | 12694.00 | 2072.00 |
| April | 19 | 2003 | 1320635.00 | 281912.00 | 1144194.00 | 222654.00 | 15436.00 | 2618.00 |
| April | 26 | 2003 | 1348996.00 | 289826.00 | 1136974.00 | 176780.00 | 14599.00 | 2343.00 |
| May | 3 | 2003 | 1547768.00 | 341846.00 | 1669468.00 | 311870.00 | 18529.00 | 3969.00 |
| May | 10 | 2003 | 1920942.00 | 374627.00 | 1849890.00 | 339641.00 | 15217.00 | 3571.00 |
| May | 17 | 2003 | 1542753.00 | 354396.00 | 1317990.00 | 218024.00 | 17792.00 | 3000.00 |
| May | 24 | 2003 | 1694129.00 | 393781.00 | 1179259.00 | 170919.00 | 39450.00 | 7876.00 |
| May | 31 | 2003 | 1588313.00 | 355542.00 | 1257329.00 | 194663.00 | 40496.00 | 8132.00 |
| June | 7 | 2003 | 1537604.00 | 340348.00 | 1241055.00 | 189141.00 | 38773.00 | 8702.00 |
| June | 14 | 2003 | 1539950.00 | 349255.00 | 1314553.00 | 208690.00 | 38107.00 | 8899.00 |
| June | 21 | 2003 | 1911273.00 | 378714.00 | 1136348.00 | 167015.00 | 39732.00 | 8913.00 |
| June | 28 | 2003 | 1517755.00 | 332317.00 | 1216047.00 | 193095.00 | 36864.00 | 8447.00 |
| July | 5 | 2003 | 1700928.00 | 375366.00 | 1203331.00 | 178424.00 | 35917.00 | 7731.00 |
| July | 12 | 2003 | 1433717.00 | 318446.00 | 1276116.00 | 201472.00 | 31807.00 | 6840.00 |
| July | 19 | 2003 | 1591933.00 | 342445.00 | 1212046.00 | 178435.00 | 36212.00 | 7926.00 |
| July | 26 | 2003 | 1908712.00 | 390693.00 | 1212376.00 | 197141.00 | 29753.00 | 6571.00 |
| Aug | 2 | 2003 | 1656063.00 | 369423.00 | 1199215.00 | 184949.00 | 34527.00 | 7391.00 |
| Aug | 9 | 2003 | 1504327.00 | 343613.00 | 1246223.00 | 200568.00 | 28694.00 | 6477.00 |
| Aug | 16 | 2003 | 1297875.00 | 279716.00 | 1126829.00 | 190991.00 | 27347.00 | 5782.00 |
| Aug | 23 | 2003 | 1377337.00 | 303009.00 | 1191452.00 | 207851.00 | 33317.00 | 8171.00 |
| Aug | 30 | 2003 | 1546614.00 | 343056.00 | 1284335.00 | 219415.00 | 34069.00 | 7255.00 |
| Sep | 6 | 2003 | 1829020.00 | 360959.00 | 1171125.00 | 168957.00 | 30630.00 | 6555.00 |
| Sep | 13 | 2003 | 1408663.00 | 310441.00 | 1315063.00 | 208809.00 | 26649.00 | 5614.00 |
| Sep | 20 | 2003 | 1688552.00 | 356599.00 | 1145092.00 | 172806.00 | 30765.00 | 6602.00 |
| Sep | 27 | 2003 | 1462505.00 | 326060.00 | 1173016.00 | 191733.00 | 29875.00 | 6381.00 |
| Oct | 4 | 2003 | 1869433.00 | 371028.00 | 1194718.00 | 230873.00 | 32917.00 | 7044.00 |
| Oct | 11 | 2003 | 1358826.00 | 291553.00 | 1129296.00 | 172272.00 | 29777.00 | 6426.00 |
| Oct | 18 | 2003 | 1138752.00 | 253664.00 | 946495.00 | 146552.00 | 23680.00 | 5792.00 |
| Oct | 25 | 2003 | 1544684.00 | 338605.00 | 1176128.00 | 177960.00 | 32869.00 | 6946.00 |
| Nov | 1 | 2003 | 1571552.00 | 352244.00 | 1297988.00 | 211627.00 | 31278.00 | 6748.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | whole11 | whole12 | brst11 | brst12 | legs11 | legs12 |
| Nov | 11 | 2000 | 3552168.00 | 694479.00 | 9625335.00 | 883914.00 | 1417888.00 | 524435.00 |
| Nov | 18 | 2000 | 4309921.00 | 854359.00 | 9647156.00 | 870976.00 | 1292076.00 | 486391.00 |
| Nov | 25 | 2000 | 3990770.00 | 788683.00 | 9270857.00 | 838559.00 | 1426752.00 | 541052.00 |
| Dec | 2 | 2000 | 4856949.00 | 1040958.00 | 9014778.00 | 824122.00 | 1502904.00 | 531995.00 |
| Dec | 9 | 2000 | 4957725.00 | 1031286.00 | 10796243.00 | 1033061.00 | 1492031.00 | 547302.00 |
| Dec | 16 | 2000 | 4599401.00 | 1065645.00 | 9017558.00 | 867294.00 | 1193402.00 | 427038.00 |
| Dec | 23 | 2000 | 4561689.00 | 1085697.00 | 8019820.00 | 719889.00 | 1150003.00 | 410241.00 |
| Dec | 30 | 2000 | 2420984.00 | 481339.00 | 5968931.00 | 504632.00 | 793310.00 | 284439.00 |
| Jan | 6 | 2001 | 2997028.00 | 594920.00 | 8326467.00 | 754355.00 | 1128597.00 | 397137.00 |
| Jan | 13 | 2001 | 4364825.00 | 997257.00 | 10224248.00 | 985749.00 | 1660548.00 | 629996.00 |
| Jan | 20 | 2001 | 3992943.00 | 820831.00 | 11772648.00 | 1019135.00 | 1343454.00 | 480757.00 |
| Jan | 27 | 2001 | 4432332.00 | 1022263.00 | 10088425.00 | 982490.00 | 1303897.00 | 471637.00 |
| Feb | 3 | 2001 | 5181769.00 | 1092041.00 | 10826222.00 | 1015252.00 | 1703226.00 | 646817.00 |
| Feb | 10 | 2001 | 3956698.00 | 787249.00 | 9724410.00 | 889760.00 | 1352107.00 | 517148.00 |
| Feb | 17 | 2001 | 4490399.00 | 922242.00 | 11006554.00 | 974033.00 | 1276885.00 | 477743.00 |
| Feb | 24 | 2001 | 3871487.00 | 740157.00 | 9890760.00 | 896257.00 | 1567909.00 | 629411.00 |
| Mar | 3 | 2001 | 4522616.00 | 919968.00 | 10510916.00 | 1006254.00 | 1571263.00 | 576616.00 |
| Mar | 10 | 2001 | 4306825.00 | 862269.00 | 10291253.00 | 982925.00 | 2033973.00 | 663954.00 |
| Mar | 17 | 2001 | 4350882.00 | 864723.00 | 9530802.00 | 891290.00 | 1586781.00 | 612834.00 |
| Mar | 24 | 2001 | 4096590.00 | 830623.00 | 10151771.00 | 905179.00 | 1472927.00 | 547420.00 |
| Mar | 31 | 2001 | 5728374.00 | 1553664.00 | 11790011.00 | 1062490.00 | 1433283.00 | 571487.00 |
| April | 7 | 2001 | 5271850.00 | 1223099.00 | 10731722.00 | 964879.00 | 1545646.00 | 549105.00 |
| April | 14 | 2001 | 3727762.00 | 709890.00 | 9125751.00 | 786855.00 | 1187876.00 | 411807.00 |
| April | 21 | 2001 | 3165467.00 | 601517.00 | 8672361.00 | 751467.00 | 1416395.00 | 500082.00 |
| April | 28 | 2001 | 4038016.00 | 785464.00 | 10893759.00 | 1039816.00 | 1423864.00 | 496228.00 |
| May | 5 | 2001 | 3885588.00 | 729788.00 | 11965117.00 | 1113340.00 | 1963180.00 | 785500.00 |
| May | 12 | 2001 | 3981115.00 | 743995.00 | 13068776.00 | 1219989.00 | 1752206.00 | 667472.00 |
| May | 19 | 2001 | 4279070.00 | 1039687.00 | 11856631.00 | 1100587.00 | 1434274.00 | 525459.00 |
| May | 26 | 2001 | 3341595.00 | 629522.00 | 10357941.00 | 941019.00 | 1433749.00 | 506820.00 |
| June | 2 | 2001 | 5013110.00 | 1068883.00 | 11997116.00 | 1039894.00 | 1725551.00 | 690338.00 |
| June | 9 | 2001 | 4263576.00 | 808368.00 | 10477001.00 | 942458.00 | 1838574.00 | 647478.00 |
| June | 16 | 2001 | 3597646.00 | 664247.00 | 10652557.00 | 998641.00 | 1370785.00 | 492427.00 |
| June | 23 | 2001 | 3479995.00 | 641359.00 | 10566737.00 | 968628.00 | 1693541.00 | 654242.00 |
| June | 30 | 2001 | 3600183.00 | 650573.00 | 11188413.00 | 1013049.00 | 1966474.00 | 688463.00 |
| July | 7 | 2001 | 3391262.00 | 618783.00 | 10796297.00 | 967188.00 | 1536303.00 | 579367.00 |
| July | 14 | 2001 | 3834863.00 | 686101.00 | 10625640.00 | 962115.00 | 1363224.00 | 504576.00 |
| July | 21 | 2001 | 4291903.00 | 980208.00 | 10115925.00 | 910678.00 | 1683601.00 | 600703.00 |
| July | 28 | 2001 | 3754893.00 | 697349.00 | 10559820.00 | 925247.00 | 1541247.00 | 596012.00 |
| Aug | 4 | 2001 | 4670344.00 | 922726.00 | 12584238.00 | 1127631.00 | 1480026.00 | 554510.00 |
| Aug | 11 | 2001 | 3495992.00 | 628258.00 | 9946284.00 | 885095.00 | 1273078.00 | 471424.00 |
| Aug | 18 | 2001 | 3665607.00 | 657673.00 | 11634411.00 | 960317.00 | 1578855.00 | 598049.00 |
| Aug | 25 | 2001 | 3995196.00 | 755243.00 | 10830539.00 | 1082861.00 | 1420238.00 | 502959.00 |
| Sep | 1 | 2001 | 4657592.00 | 876394.00 | 12530815.00 | 1135265.00 | 1519175.00 | 523868.00 |
| Sep | 8 | 2001 | 3833834.00 | 708540.00 | 11536516.00 | 1097183.00 | 1424335.00 | 502569.00 |
| Sep | 15 | 2001 | 4129354.00 | 770705.00 | 10534731.00 | 1003564.00 | 1483750.00 | 538185.00 |
| Sep | 22 | 2001 | 4763713.00 | 899231.00 | 10711411.00 | 968622.00 | 1413302.00 | 494978.00 |
| Sep | 29 | 2001 | 4027977.00 | 741941.00 | 10500660.00 | 913288.00 | 1709298.00 | 622435.00 |
| Oct | 6 | 2001 | 4082253.00 | 750977.00 | 9126721.00 | 789030.00 | 1512151.00 | 520592.00 |
| Oct | 13 | 2001 | 3319379.00 | 619078.00 | 8475639.00 | 713171.00 | 1729819.00 | 588928.00 |
| Oct | 20 | 2001 | 4712257.00 | 903978.00 | 10707598.00 | 940340.00 | 1832774.00 | 741345.00 |
| Oct | 27 | 2001 | 5001568.00 | 983520.00 | 10759999.00 | 993799.00 | 1499691.00 | 558692.00 |
| Nov | 3 | 2001 | 4724316.00 | 949048.00 | 11985334.00 | 1074147.00 | 1898883.00 | 725407.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | whole11 | whole12 | brst11 | brst12 | legs11 | legs12 |
| Nov | 10 | 2001 | 4664579.00 | 893927.00 | 9787632.00 | 829878.00 | 1274096.00 | 470229.00 |
| Nov | 17 | 2001 | 4699640.00 | 975634.00 | 9367033.00 | 802265.00 | 1755285.00 | 622578.00 |
| Nov | 24 | 2001 | 4834868.00 | 992284.00 | 9359606.00 | 810178.00 | 1597771.00 | 654865.00 |
| Dec | 1 | 2001 | 4938686.00 | 1079235.00 | 10651662.00 | 895074.00 | 2043988.00 | 832367.00 |
| Dec | 8 | 2001 | 5193447.00 | 1023711.00 | 10267167.00 | 950700.00 | 1279274.00 | 478916.00 |
| Dec | 15 | 2001 | 4057414.00 | 740141.00 | 10196957.00 | 939379.00 | 1185185.00 | 437634.00 |
| Dec | 22 | 2001 | 4997258.00 | 1200847.00 | 8711656.00 | 760624.00 | 1151987.00 | 422100.00 |
| Dec | 29 | 2001 | 2728077.00 | 555674.00 | 5895073.00 | 484998.00 | 798029.00 | 292129.00 |
| Jan | 5 | 2002 | 3185541.00 | 597367.00 | 9325485.00 | 802062.00 | 1222077.00 | 425959.00 |
| Jan | 12 | 2002 | 4097450.00 | 760699.00 | 13272914.00 | 1217750.00 | 2055250.00 | 712414.00 |
| Jan | 19 | 2002 | 4955218.00 | 1030539.00 | 13533922.00 | 1353272.00 | 1626098.00 | 594901.00 |
| Jan | 26 | 2002 | 4384191.00 | 812841.00 | 12144277.00 | 1213220.00 | 1786338.00 | 660102.00 |
| Feb | 2 | 2002 | 5258695.00 | 1176568.00 | 11413371.00 | 1058884.00 | 1893544.00 | 685793.00 |
| Feb | 9 | 2002 | 4435921.00 | 872364.00 | 10711358.00 | 972109.00 | 1415047.00 | 557773.00 |
| Feb | 16 | 2002 | 5472937.00 | 1273920.00 | 9866084.00 | 908327.00 | 1315851.00 | 496694.00 |
| Feb | 23 | 2002 | 4480109.00 | 998588.00 | 10559807.00 | 978148.00 | 1503080.00 | 523915.00 |
| Mar | 2 | 2002 | 5611564.00 | 1264860.00 | 10177199.00 | 963589.00 | 1456904.00 | 506122.00 |
| Mar | 9 | 2002 | 4255659.00 | 824462.00 | 11208095.00 | 1014797.00 | 1420330.00 | 518500.00 |
| Mar | 16 | 2002 | 3800846.00 | 717977.00 | 12207713.00 | 1136854.00 | 1627913.00 | 569442.00 |
| Mar | 23 | 2002 | 4277086.00 | 829884.00 | 10909898.00 | 993696.00 | 1577124.00 | 622210.00 |
| Mar | 30 | 2002 | 4179345.00 | 873986.00 | 9041202.00 | 753437.00 | 1237326.00 | 451740.00 |
| April | 6 | 2002 | 5207530.00 | 959437.00 | 9617899.00 | 869567.00 | 1516667.00 | 530141.00 |
| April | 13 | 2002 | 5545139.00 | 1171314.00 | 11464107.00 | 1129468.00 | 1671969.00 | 645971.00 |
| April | 20 | 2002 | 3877334.00 | 805179.00 | 12776241.00 | 1291039.00 | 1853572.00 | 574747.00 |
| April | 27 | 2002 | 5583020.00 | 1314366.00 | 11808791.00 | 1119993.00 | 1484388.00 | 532477.00 |
| May | 4 | 2002 | 4572115.00 | 916447.00 | 11107964.00 | 1079454.00 | 1792281.00 | 594231.00 |
| May | 11 | 2002 | 4411931.00 | 807390.00 | 12259614.00 | 1202934.00 | 1419915.00 | 590314.00 |
| May | 18 | 2002 | 5507124.00 | 1053076.00 | 10275926.00 | 911305.00 | 1457830.00 | 490325.00 |
| May | 25 | 2002 | 4178667.00 | 815805.00 | 10647996.00 | 932956.00 | 1538414.00 | 662885.00 |
| June | 1 | 2002 | 4572465.00 | 938043.00 | 14050858.00 | 1427549.00 | 1515206.00 | 545029.00 |
| June | 8 | 2002 | 3708687.00 | 682867.00 | 11218791.00 | 1011994.00 | 1783670.00 | 684081.00 |
| June | 15 | 2002 | 3898769.00 | 724859.00 | 12611877.00 | 1031497.00 | 1357164.00 | 468028.00 |
| June | 22 | 2002 | 3741123.00 | 670254.00 | 11160309.00 | 1123040.00 | 1535492.00 | 503073.00 |
| June | 29 | 2002 | 3745660.00 | 666167.00 | 12307025.00 | 1129629.00 | 1388759.00 | 498640.00 |
| July | 6 | 2002 | 3635309.00 | 666073.00 | 11509714.00 | 1020260.00 | 1649294.00 | 570128.00 |
| July | 13 | 2002 | 3703361.00 | 662152.00 | 10480637.00 | 962074.00 | 1295574.00 | 454977.00 |
| July | 20 | 2002 | 3789920.00 | 668292.00 | 13756691.00 | 1134719.00 | 1307810.00 | 454086.00 |
| July | 27 | 2002 | 3913872.00 | 667068.00 | 10969885.00 | 961556.00 | 1335649.00 | 464045.00 |
| Aug | 3 | 2002 | 4664190.00 | 972759.00 | 11269623.00 | 1025048.00 | 1410073.00 | 513232.00 |
| Aug | 10 | 2002 | 3879744.00 | 717358.00 | 10719361.00 | 986648.00 | 1206102.00 | 453355.00 |
| Aug | 17 | 2002 | 3938429.00 | 730815.00 | 10573937.00 | 988810.00 | 1413280.00 | 497733.00 |
| Aug | 24 | 2002 | 3740387.00 | 663972.00 | 10617395.00 | 917365.00 | 1318417.00 | 479664.00 |
| Aug | 31 | 2002 | 4365709.00 | 807041.00 | 12674530.00 | 1230852.00 | 1479823.00 | 503159.00 |
| Sep | 7 | 2002 | 4489589.00 | 896043.00 | 14258121.00 | 1131671.00 | 1935638.00 | 704835.00 |
| Sep | 14 | 2002 | 4495837.00 | 962167.00 | 11001198.00 | 1043006.00 | 1792882.00 | 793414.00 |
| Sep | 21 | 2002 | 4587969.00 | 846683.00 | 10842800.00 | 1020276.00 | 1945142.00 | 693469.00 |
| Sep | 28 | 2002 | 4013564.00 | 742686.00 | 12528755.00 | 1282935.00 | 1327431.00 | 477097.00 |
| Oct | 5 | 2002 | 4608049.00 | 1031263.00 | 11924504.00 | 1065569.00 | 1380461.00 | 477904.00 |
| Oct | 12 | 2002 | 4037221.00 | 750976.00 | 8760829.00 | 753849.00 | 1144504.00 | 382675.00 |
| Oct | 19 | 2002 | 3518329.00 | 651615.00 | 8844088.00 | 796308.00 | 1425430.00 | 459170.00 |
| Oct | 26 | 2002 | 4917390.00 | 953042.00 | 11390617.00 | 984809.00 | 1377707.00 | 469056.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | whole11 | whole12 | brst11 | brst12 | legs11 | legs12 |
| Nov | 2 | 2002 | 6811520.00 | 1402057.00 | 12162972.00 | 1092699.00 | 1565202.00 | 622323.00 |
| Nov | 9 | 2002 | 4457443.00 | 899807.00 | 12510561.00 | 1046764.00 | 1694678.00 | 579534.00 |
| Nov | 16 | 2002 | 5380435.00 | 1321935.00 | 10217034.00 | 866772.00 | 1720803.00 | 570923.00 |
| Nov | 23 | 2002 | 5024105.00 | 1174735.00 | 14899333.00 | 1285638.00 | 1672012.00 | 518557.00 |
| Nov | 30 | 2002 | 4618590.00 | 910006.00 | 12370266.00 | 1226912.00 | 1512210.00 | 639971.00 |
| Dec | 7 | 2002 | 4760059.00 | 934123.00 | 11950807.00 | 1248801.00 | 1586212.00 | 516513.00 |
| Dec | 14 | 2002 | 4469612.00 | 885654.00 | 10100971.00 | 979721.00 | 1308415.00 | 440269.00 |
| Dec | 21 | 2002 | 3989209.00 | 717215.00 | 8661886.00 | 758660.00 | 1114479.00 | 367163.00 |
| Dec | 28 | 2002 | 2683831.00 | 498519.00 | 6057508.00 | 506350.00 | 739549.00 | 249439.00 |
| Jan | 4 | 2003 | 3206160.00 | 629968.00 | 8617822.00 | 720075.00 | 1110365.00 | 399529.00 |
| Jan | 11 | 2003 | 5013554.00 | 1071111.00 | 12328339.00 | 1117220.00 | 1904809.00 | 624962.00 |
| Jan | 18 | 2003 | 6191928.00 | 1258434.00 | 11704516.00 | 1014691.00 | 1573316.00 | 586690.00 |
| Jan | 25 | 2003 | 4838719.00 | 987835.00 | 11812214.00 | 1126657.00 | 1611284.00 | 586954.00 |
| Feb | 1 | 2003 | 5276552.00 | 1237527.00 | 14629027.00 | 1431663.00 | 1875711.00 | 633640.00 |
| Feb | 8 | 2003 | 5260921.00 | 948748.00 | 11832586.00 | 1132883.00 | 1367894.00 | 478210.00 |
| Feb | 15 | 2003 | 4316984.00 | 789801.00 | 10309125.00 | 922857.00 | 1673707.00 | 548461.00 |
| Feb | 22 | 2003 | 4754775.00 | 949608.00 | 11531824.00 | 1014779.00 | 1567701.00 | 619306.00 |
| Mar | 1 | 2003 | 6734420.00 | 1898892.00 | 11877360.00 | 1084677.00 | 2129234.00 | 727255.00 |
| Mar | 8 | 2003 | 6401387.00 | 1781771.00 | 11036418.00 | 995115.00 | 1528525.00 | 561810.00 |
| Mar | 15 | 2003 | 4094575.00 | 728218.00 | 11594108.00 | 1047099.00 | 1245324.00 | 436583.00 |
| Mar | 22 | 2003 | 5140809.00 | 924938.00 | 11984463.00 | 1157659.00 | 1438042.00 | 495584.00 |
| Mar | 29 | 2003 | 4388032.00 | 801134.00 | 12006748.00 | 1109113.00 | 1378112.00 | 491164.00 |
| April | 5 | 2003 | 6007409.00 | 1361992.00 | 11965923.00 | 1033973.00 | 1698973.00 | 620924.00 |
| April | 12 | 2003 | 4691772.00 | 964498.00 | 11565737.00 | 962309.00 | 1907301.00 | 646180.00 |
| April | 19 | 2003 | 4059853.00 | 717724.00 | 10737532.00 | 957819.00 | 1609324.00 | 599135.00 |
| April | 26 | 2003 | 3683454.00 | 644338.00 | 11073996.00 | 1069624.00 | 1733659.00 | 569900.00 |
| May | 3 | 2003 | 4731384.00 | 977479.00 | 14294024.00 | 1313696.00 | 1679166.00 | 591841.00 |
| May | 10 | 2003 | 4534118.00 | 789794.00 | 13267870.00 | 1190183.00 | 1501306.00 | 541968.00 |
| May | 17 | 2003 | 5207903.00 | 1124404.00 | 11747542.00 | 1045210.00 | 1847518.00 | 576667.00 |
| May | 24 | 2003 | 4977373.00 | 1085146.00 | 11633580.00 | 1002874.00 | 1524958.00 | 548442.00 |
| May | 31 | 2003 | 5994477.00 | 1181442.00 | 14348102.00 | 1461072.00 | 2118327.00 | 687588.00 |
| June | 7 | 2003 | 5749567.00 | 1066195.00 | 14996763.00 | 1402313.00 | 1628931.00 | 566078.00 |
| June | 14 | 2003 | 4008701.00 | 687104.00 | 12915337.00 | 1127145.00 | 1732749.00 | 549283.00 |
| June | 21 | 2003 | 3588744.00 | 606403.00 | 12340777.00 | 1127556.00 | 1805575.00 | 715454.00 |
| June | 28 | 2003 | 3868298.00 | 645944.00 | 12501903.00 | 1137061.00 | 1484577.00 | 523002.00 |
| July | 5 | 2003 | 4172863.00 | 720621.00 | 11355821.00 | 977422.00 | 1621185.00 | 589569.00 |
| July | 12 | 2003 | 5651095.00 | 1191144.00 | 11732336.00 | 1019740.00 | 1816735.00 | 603447.00 |
| July | 19 | 2003 | 3925651.00 | 675049.00 | 13228908.00 | 1146228.00 | 1575981.00 | 609542.00 |
| July | 26 | 2003 | 3976916.00 | 685786.00 | 11748095.00 | 1048757.00 | 1628193.00 | 615694.00 |
| Aug | 2 | 2003 | 4992743.00 | 849886.00 | 12401487.00 | 1109842.00 | 1878362.00 | 618685.00 |
| Aug | 9 | 2003 | 3902372.00 | 688191.00 | 10811968.00 | 955862.00 | 1412005.00 | 500087.00 |
| Aug | 16 | 2003 | 4453450.00 | 967817.00 | 11400496.00 | 957649.00 | 1382530.00 | 510683.00 |
| Aug | 23 | 2003 | 4328252.00 | 884088.00 | 10324195.00 | 876460.00 | 1605434.00 | 565934.00 |
| Aug | 30 | 2003 | 4621036.00 | 845838.00 | 13718571.00 | 1135373.00 | 1510814.00 | 540903.00 |
| Sep | 6 | 2003 | 4831186.00 | 990571.00 | 12500663.00 | 1091317.00 | 1501289.00 | 544150.00 |
| Sep | 13 | 2003 | 4881369.00 | 1015452.00 | 12308136.00 | 1120152.00 | 2126993.00 | 698710.00 |
| Sep | 20 | 2003 | 5856582.00 | 1204795.00 | 11447228.00 | 976958.00 | 1383764.00 | 497792.00 |
| Sep | 27 | 2003 | 6910890.00 | 1282831.00 | 12473577.00 | 1205475.00 | 1928326.00 | 638857.00 |
| Oct | 4 | 2003 | 5487742.00 | 1012867.00 | 11262377.00 | 1041793.00 | 1641855.00 | 604763.00 |
| Oct | 11 | 2003 | 4440435.00 | 769780.00 | 9757247.00 | 922731.00 | 1482795.00 | 515536.00 |
| Oct | 18 | 2003 | 3742804.00 | 666726.00 | 9221977.00 | 799503.00 | 1718059.00 | 615488.00 |
| Oct | 25 | 2003 | 4562106.00 | 850625.00 | 12771837.00 | 1038868.00 | 1713447.00 | 701920.00 |
| Nov | 1 | 2003 | 5376133.00 | 1105315.00 | 14303725.00 | 1231259.00 | 2126061.00 | 638014.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | wingt11 | wingt12 | kabob11 | kabob12 | nugg11 | nugg12 |
| Nov | 11 | 2000 | 27128.00 | 5223.00 | 60531.00 | 5185.00 | 14347.00 | 2723.00 |
| Nov | 18 | 2000 | 28246.00 | 5456.00 | 54004.00 | 4240.00 | 17149.00 | 3000.00 |
| Nov | 25 | 2000 | 28197.00 | 5286.00 | 48815.00 | 4771.00 | 17973.00 | 2409.00 |
| Dec | 2 | 2000 | 29316.00 | 5617.00 | 47515.00 | 4722.00 | 20532.00 | 3669.00 |
| Dec | 9 | 2000 | 28573.00 | 5018.00 | 50017.00 | 5206.00 | 15510.00 | 3058.00 |
| Dec | 16 | 2000 | 27015.00 | 4741.00 | 45118.00 | 4460.00 | 16558.00 | 2202.00 |
| Dec | 23 | 2000 | 34825.00 | 6165.00 | 51688.00 | 4899.00 | 17363.00 | 3449.00 |
| Dec | 30 | 2000 | 30528.00 | 5441.00 | 44360.00 | 4364.00 | 13027.00 | 2528.00 |
| Jan | 6 | 2001 | 23743.00 | 4137.00 | 46922.00 | 4517.00 | 16137.00 | 2972.00 |
| Jan | 13 | 2001 | 27468.00 | 4802.00 | 48479.00 | 4997.00 | 18164.00 | 2999.00 |
| Jan | 20 | 2001 | 28373.00 | 4992.00 | 51704.00 | 4649.00 | 19016.00 | 3105.00 |
| Jan | 27 | 2001 | 32583.00 | 5810.00 | 47218.00 | 4433.00 | 16687.00 | 2650.00 |
| Feb | 3 | 2001 | 33545.00 | 6172.00 | 49216.00 | 5251.00 | 22177.00 | 2642.00 |
| Feb | 10 | 2001 | 28906.00 | 5313.00 | 67415.00 | 6456.00 | 16904.00 | 2027.00 |
| Feb | 17 | 2001 | 30563.00 | 5630.00 | 77989.00 | 7743.00 | 17387.00 | 2263.00 |
| Feb | 24 | 2001 | 30493.00 | 5649.00 | 55799.00 | 5760.00 | 18659.00 | 2251.00 |
| Mar | 3 | 2001 | 32928.00 | 6131.00 | 63058.00 | 6954.00 | 19785.00 | 2395.00 |
| Mar | 10 | 2001 | 33873.00 | 6298.00 | 75498.00 | 7384.00 | 18562.00 | 2224.00 |
| Mar | 17 | 2001 | 32519.00 | 6098.00 | 58784.00 | 6095.00 | 17398.00 | 2084.00 |
| Mar | 24 | 2001 | 34192.00 | 6320.00 | 65297.00 | 6984.00 | 18988.00 | 2247.00 |
| Mar | 31 | 2001 | 35533.00 | 6649.00 | 63236.00 | 7210.00 | 23052.00 | 2719.00 |
| April | 7 | 2001 | 33698.00 | 6256.00 | 87296.00 | 8808.00 | 16638.00 | 2601.00 |
| April | 14 | 2001 | 34800.00 | 6526.00 | 104302.00 | 11205.00 | 15945.00 | 2881.00 |
| April | 21 | 2001 | 32398.00 | 6012.00 | 126147.00 | 13689.00 | 17735.00 | 2758.00 |
| April | 28 | 2001 | 32979.00 | 6022.00 | 187083.00 | 19600.00 | 17736.00 | 2301.00 |
| May | 5 | 2001 | 37511.00 | 7011.00 | 631961.00 | 58811.00 | 18142.00 | 2349.00 |
| May | 12 | 2001 | 37526.00 | 6948.00 | 338256.00 | 33081.00 | 17605.00 | 2308.00 |
| May | 19 | 2001 | 40141.00 | 7432.00 | 348387.00 | 35270.00 | 18040.00 | 2437.00 |
| May | 26 | 2001 | 34764.00 | 6513.00 | 279898.00 | 27243.00 | 16123.00 | 2262.00 |
| June | 2 | 2001 | 39153.00 | 7329.00 | 210387.00 | 22186.00 | 23964.00 | 2773.00 |
| June | 9 | 2001 | 41277.00 | 7606.00 | 287072.00 | 31735.00 | 18072.00 | 2021.00 |
| June | 16 | 2001 | 36281.00 | 6671.00 | 315514.00 | 33733.00 | 17903.00 | 2045.00 |
| June | 23 | 2001 | 35019.00 | 6417.00 | 325110.00 | 37301.00 | 15849.00 | 2108.00 |
| June | 30 | 2001 | 39539.00 | 7268.00 | 337700.00 | 38665.00 | 17581.00 | 2264.00 |
| July | 7 | 2001 | 37132.00 | 6858.00 | 284890.00 | 31780.00 | 17624.00 | 2286.00 |
| July | 14 | 2001 | 40046.00 | 7353.00 | 321407.00 | 37154.00 | 16378.00 | 2161.00 |
| July | 21 | 2001 | 40321.00 | 7402.00 | 307850.00 | 33176.00 | 18700.00 | 2389.00 |
| July | 28 | 2001 | 41514.00 | 7639.00 | 333762.00 | 37829.00 | 18078.00 | 2026.00 |
| Aug | 4 | 2001 | 35127.00 | 6289.00 | 324680.00 | 34880.00 | 17988.00 | 2613.00 |
| Aug | 11 | 2001 | 45561.00 | 8431.00 | 290970.00 | 30329.00 | 16618.00 | 2554.00 |
| Aug | 18 | 2001 | 44083.00 | 8156.00 | 241401.00 | 21973.00 | 17868.00 | 2386.00 |
| Aug | 25 | 2001 | 31632.00 | 5641.00 | 219560.00 | 23266.00 | 15842.00 | 2155.00 |
| Sep | 1 | 2001 | 41421.00 | 7600.00 | 235430.00 | 24623.00 | 16581.00 | 1993.00 |
| Sep | 8 | 2001 | 41417.00 | 7635.00 | 214198.00 | 21655.00 | 12985.00 | 1942.00 |
| Sep | 15 | 2001 | 40423.00 | 7414.00 | 150347.00 | 13040.00 | 14937.00 | 1651.00 |
| Sep | 22 | 2001 | 40838.00 | 7564.00 | 121028.00 | 10520.00 | 15721.00 | 1726.00 |
| Sep | 29 | 2001 | 42001.00 | 7644.00 | 107240.00 | 9558.00 | 16100.00 | 1725.00 |
| Oct | 6 | 2001 | 41709.00 | 7586.00 | 77483.00 | 6512.00 | 13860.00 | 1487.00 |
| Oct | 13 | 2001 | 39285.00 | 7219.00 | 81205.00 | 6373.00 | 13581.00 | 1464.00 |
| Oct | 20 | 2001 | 42078.00 | 7788.00 | 74674.00 | 5842.00 | 16155.00 | 1891.00 |
| Oct | 27 | 2001 | 44174.00 | 8066.00 | 82024.00 | 6777.00 | 14987.00 | 1628.00 |
| Nov | 3 | 2001 | 45245.00 | 8247.00 | 76753.00 | 5830.00 | 17754.00 | 1933.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | wingt11 | wingt12 | kabob11 | kabob12 | nugg11 | nugg12 |
| Nov | 10 | 2001 | 46992.00 | 8682.00 | 72919.00 | 5544.00 | 14380.00 | 1569.00 |
| Nov | 17 | 2001 | 36805.00 | 6724.00 | 56210.00 | 4334.00 | 13555.00 | 1461.00 |
| Nov | 24 | 2001 | 41570.00 | 7798.00 | 72747.00 | 5663.00 | 13942.00 | 2333.00 |
| Dec | 1 | 2001 | 44301.00 | 8084.00 | 78832.00 | 6032.00 | 15722.00 | 1783.00 |
| Dec | 8 | 2001 | 42028.00 | 7783.00 | 66320.00 | 4828.00 | 13214.00 | 1398.00 |
| Dec | 15 | 2001 | 46881.00 | 8028.00 | 63819.00 | 4825.00 | 13722.00 | 1472.00 |
| Dec | 22 | 2001 | 52682.00 | 8852.00 | 63857.00 | 4530.00 | 14146.00 | 2235.00 |
| Dec | 29 | 2001 | 40460.00 | 6811.00 | 62346.00 | 4748.00 | 9479.00 | 987.00 |
| Jan | 5 | 2002 | 46331.00 | 7649.00 | 76142.00 | 5539.00 | 12207.00 | 1258.00 |
| Jan | 12 | 2002 | 47387.00 | 8567.00 | 66793.00 | 4731.00 | 18450.00 | 2360.00 |
| Jan | 19 | 2002 | 41322.00 | 7606.00 | 76583.00 | 5840.00 | 14216.00 | 1468.00 |
| Jan | 26 | 2002 | 41345.00 | 7488.00 | 76060.00 | 5299.00 | 19816.00 | 2040.00 |
| Feb | 2 | 2002 | 46239.00 | 8425.00 | 93979.00 | 7454.00 | 14860.00 | 2075.00 |
| Feb | 9 | 2002 | 48145.00 | 8762.00 | 83184.00 | 6253.00 | 13733.00 | 2010.00 |
| Feb | 16 | 2002 | 37531.00 | 6900.00 | 85593.00 | 6178.00 | 11151.00 | 1174.00 |
| Feb | 23 | 2002 | 42148.00 | 7860.00 | 93973.00 | 7342.00 | 13401.00 | 1987.00 |
| Mar | 2 | 2002 | 41355.00 | 7711.00 | 81732.00 | 6056.00 | 17000.00 | 2128.00 |
| Mar | 9 | 2002 | 38346.00 | 7243.00 | 71044.00 | 5033.00 | 15217.00 | 2310.00 |
| Mar | 16 | 2002 | 40199.00 | 7551.00 | 67906.00 | 4744.00 | 13862.00 | 1604.00 |
| Mar | 23 | 2002 | 38846.00 | 7290.00 | 64318.00 | 4588.00 | 12954.00 | 1968.00 |
| Mar | 30 | 2002 | 37001.00 | 6966.00 | 77594.00 | 5531.00 | 13307.00 | 1602.00 |
| April | 6 | 2002 | 36271.00 | 6832.00 | 79896.00 | 5589.00 | 13458.00 | 2115.00 |
| April | 13 | 2002 | 36165.00 | 6771.00 | 150194.00 | 11494.00 | 13975.00 | 1654.00 |
| April | 20 | 2002 | 41708.00 | 7832.00 | 180380.00 | 14159.00 | 15928.00 | 1928.00 |
| April | 27 | 2002 | 38816.00 | 7273.00 | 181034.00 | 13549.00 | 15813.00 | 1953.00 |
| May | 4 | 2002 | 37030.00 | 6885.00 | 301559.00 | 24797.00 | 15664.00 | 1836.00 |
| May | 11 | 2002 | 41154.00 | 7697.00 | 256781.00 | 21985.00 | 16880.00 | 2361.00 |
| May | 18 | 2002 | 41471.00 | 7822.00 | 295843.00 | 26999.00 | 21767.00 | 2929.00 |
| May | 25 | 2002 | 39784.00 | 7401.00 | 377199.00 | 36225.00 | 14838.00 | 1637.00 |
| June | 1 | 2002 | 41944.00 | 7939.00 | 359396.00 | 32823.00 | 18870.00 | 2084.00 |
| June | 8 | 2002 | 40890.00 | 7975.00 | 412522.00 | 37904.00 | 15516.00 | 1730.00 |
| June | 15 | 2002 | 39412.00 | 7666.00 | 316825.00 | 28736.00 | 14698.00 | 2243.00 |
| June | 22 | 2002 | 37909.00 | 7304.00 | 402094.00 | 30836.00 | 14441.00 | 1626.00 |
| June | 29 | 2002 | 37598.00 | 7217.00 | 481293.00 | 38547.00 | 14395.00 | 1687.00 |
| July | 6 | 2002 | 38682.00 | 7465.00 | 422402.00 | 31994.00 | 13489.00 | 2033.00 |
| July | 13 | 2002 | 37217.00 | 7211.00 | 388010.00 | 33279.00 | 12790.00 | 1460.00 |
| July | 20 | 2002 | 34545.00 | 6656.00 | 462721.00 | 40698.00 | 15693.00 | 2341.00 |
| July | 27 | 2002 | 33530.00 | 6512.00 | 460863.00 | 36749.00 | 12790.00 | 1825.00 |
| Aug | 3 | 2002 | 36153.00 | 6955.00 | 468713.00 | 37851.00 | 15386.00 | 2191.00 |
| Aug | 10 | 2002 | 36116.00 | 6985.00 | 421209.00 | 33913.00 | 13116.00 | 1471.00 |
| Aug | 17 | 2002 | 35145.00 | 6855.00 | 395102.00 | 30960.00 | 12558.00 | 2060.00 |
| Aug | 24 | 2002 | 32099.00 | 6186.00 | 322096.00 | 27760.00 | 14586.00 | 1659.00 |
| Aug | 31 | 2002 | 30490.00 | 5794.00 | 330050.00 | 25315.00 | 17149.00 | 2531.00 |
| Sep | 7 | 2002 | 36053.00 | 6881.00 | 281615.00 | 22140.00 | 14606.00 | 2215.00 |
| Sep | 14 | 2002 | 32962.00 | 6357.00 | 196857.00 | 16942.00 | 15121.00 | 1862.00 |
| Sep | 21 | 2002 | 30195.00 | 5659.00 | 142637.00 | 11181.00 | 14539.00 | 1864.00 |
| Sep | 28 | 2002 | 30612.00 | 5825.00 | 127876.00 | 8977.00 | 15539.00 | 2395.00 |
| Oct | 5 | 2002 | 33038.00 | 6275.00 | 120604.00 | 8439.00 | 15750.00 | 2295.00 |
| Oct | 12 | 2002 | 29580.00 | 5676.00 | 83413.00 | 5906.00 | 12684.00 | 2025.00 |
| Oct | 19 | 2002 | 27875.00 | 5318.00 | 83104.00 | 6027.00 | 13542.00 | 1996.00 |
| Oct | 26 | 2002 | 31718.00 | 6013.00 | 72733.00 | 5216.00 | 13275.00 | 1924.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | wingt11 | wingt12 | kabob11 | kabob12 | nugg11 | nugg12 |
| Nov | 2 | 2002 | 34898.00 | 6624.00 | 78641.00 | 5936.00 | 17074.00 | 2347.00 |
| Nov | 9 | 2002 | 31963.00 | 6057.00 | 66387.00 | 4651.00 | 16403.00 | 2366.00 |
| Nov | 16 | 2002 | 35768.00 | 6810.00 | 67760.00 | 5092.00 | 15740.00 | 2308.00 |
| Nov | 23 | 2002 | 40699.00 | 7529.00 | 64416.00 | 5086.00 | 16294.00 | 2454.00 |
| Nov | 30 | 2002 | 30123.00 | 5700.00 | 62122.00 | 4490.00 | 17425.00 | 2133.00 |
| Dec | 7 | 2002 | 34752.00 | 6608.00 | 50956.00 | 3652.00 | 15823.00 | 2447.00 |
| Dec | 14 | 2002 | 33516.00 | 6346.00 | 84370.00 | 6253.00 | 12994.00 | 2186.00 |
| Dec | 21 | 2002 | 35667.00 | 5838.00 | 64351.00 | 5284.00 | 12606.00 | 2175.00 |
| Dec | 28 | 2002 | 36077.00 | 5600.00 | 51677.00 | 3697.00 | 9446.00 | 1665.00 |
| Jan | 4 | 2003 | 40751.00 | 6347.00 | 73478.00 | 5360.00 | 15536.00 | 2296.00 |
| Jan | 11 | 2003 | 35440.00 | 7290.00 | 72232.00 | 5094.00 | 17381.00 | 2586.00 |
| Jan | 18 | 2003 | 33429.00 | 6808.00 | 56524.00 | 4870.00 | 17882.00 | 2249.00 |
| Jan | 25 | 2003 | 32141.00 | 6142.00 | 50971.00 | 4304.00 | 19066.00 | 2775.00 |
| Feb | 1 | 2003 | 32951.00 | 6378.00 | 48800.00 | 3986.00 | 19527.00 | 2396.00 |
| Feb | 8 | 2003 | 34825.00 | 7115.00 | 50823.00 | 3510.00 | 18557.00 | 2203.00 |
| Feb | 15 | 2003 | 33129.00 | 6823.00 | 69202.00 | 4857.00 | 16206.00 | 1915.00 |
| Feb | 22 | 2003 | 29342.00 | 5861.00 | 62953.00 | 4497.00 | 19355.00 | 2379.00 |
| Mar | 1 | 2003 | 30172.00 | 6097.00 | 61168.00 | 4278.00 | 18167.00 | 2278.00 |
| Mar | 8 | 2003 | 30123.00 | 6123.00 | 69302.00 | 5206.00 | 18144.00 | 2178.00 |
| Mar | 15 | 2003 | 30299.00 | 6135.00 | 55391.00 | 3735.00 | 17551.00 | 2093.00 |
| Mar | 22 | 2003 | 33976.00 | 6931.00 | 71746.00 | 5002.00 | 17970.00 | 2167.00 |
| Mar | 29 | 2003 | 33536.00 | 6769.00 | 80183.00 | 5323.00 | 17654.00 | 2201.00 |
| April | 5 | 2003 | 38758.00 | 7823.00 | 83372.00 | 8163.00 | 21653.00 | 2802.00 |
| April | 12 | 2003 | 35730.00 | 7213.00 | 165791.00 | 11217.00 | 20749.00 | 2663.00 |
| April | 19 | 2003 | 31140.00 | 6283.00 | 142843.00 | 10075.00 | 20334.00 | 2658.00 |
| April | 26 | 2003 | 29618.00 | 5958.00 | 142786.00 | 9898.00 | 18323.00 | 2306.00 |
| May | 3 | 2003 | 37706.00 | 7634.00 | 336915.00 | 23991.00 | 23440.00 | 3031.00 |
| May | 10 | 2003 | 34443.00 | 6903.00 | 358300.00 | 25878.00 | 20243.00 | 2647.00 |
| May | 17 | 2003 | 38328.00 | 7676.00 | 472642.00 | 35260.00 | 19604.00 | 2501.00 |
| May | 24 | 2003 | 39768.00 | 7948.00 | 378343.00 | 27512.00 | 20302.00 | 2725.00 |
| May | 31 | 2003 | 37908.00 | 7556.00 | 400869.00 | 28443.00 | 22971.00 | 3217.00 |
| June | 7 | 2003 | 43627.00 | 8383.00 | 428040.00 | 31232.00 | 30177.00 | 10868.00 |
| June | 14 | 2003 | 43274.00 | 8213.00 | 462562.00 | 34538.00 | 21185.00 | 2845.00 |
| June | 21 | 2003 | 40293.00 | 7568.00 | 474440.00 | 36491.00 | 21557.00 | 7870.00 |
| June | 28 | 2003 | 42333.00 | 7925.00 | 522328.00 | 37832.00 | 21695.00 | 5745.00 |
| July | 5 | 2003 | 42941.00 | 8062.00 | 545205.00 | 39877.00 | 21469.00 | 5625.00 |
| July | 12 | 2003 | 40526.00 | 7666.00 | 410381.00 | 31773.00 | 20614.00 | 7594.00 |
| July | 19 | 2003 | 42268.00 | 7871.00 | 534279.00 | 44079.00 | 19840.00 | 2803.00 |
| July | 26 | 2003 | 38645.00 | 7191.00 | 375336.00 | 28261.00 | 19682.00 | 8398.00 |
| Aug | 2 | 2003 | 42924.00 | 8046.00 | 450829.00 | 35979.00 | 23125.00 | 7025.00 |
| Aug | 9 | 2003 | 41712.00 | 7811.00 | 357516.00 | 27995.00 | 18639.00 | 7014.00 |
| Aug | 16 | 2003 | 38672.00 | 7328.00 | 368829.00 | 26691.00 | 15936.00 | 4900.00 |
| Aug | 23 | 2003 | 37826.00 | 7059.00 | 326383.00 | 23357.00 | 21062.00 | 8069.00 |
| Aug | 30 | 2003 | 43927.00 | 8140.00 | 297769.00 | 21650.00 | 22008.00 | 3133.00 |
| Sep | 6 | 2003 | 44188.00 | 8225.00 | 224925.00 | 16161.00 | 20140.00 | 4733.00 |
| Sep | 13 | 2003 | 41747.00 | 7747.00 | 188772.00 | 13687.00 | 16823.00 | 4585.00 |
| Sep | 20 | 2003 | 40891.00 | 7665.00 | 153792.00 | 12879.00 | 22708.00 | 3257.00 |
| Sep | 27 | 2003 | 41585.00 | 7742.00 | 109932.00 | 11181.00 | 23296.00 | 3999.00 |
| Oct | 4 | 2003 | 44086.00 | 8201.00 | 86440.00 | 5867.00 | 28661.00 | 8241.00 |
| Oct | 11 | 2003 | 40540.00 | 7604.00 | 84741.00 | 5858.00 | 18373.00 | 5226.00 |
| Oct | 18 | 2003 | 38025.00 | 7112.00 | 64203.00 | 4812.00 | 18388.00 | 2921.00 |
| Oct | 25 | 2003 | 40500.00 | 7548.00 | 58853.00 | 5101.00 | 24173.00 | 3481.00 |
| Nov | 1 | 2003 | 42798.00 | 7931.00 | 63036.00 | 4177.00 | 25448.00 | 3611.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | drumt11 | drumt12 | thigh11 | thigh12 | ast11 | ast12 |
| Nov | 11 | 2000 | 221940.00 | 26862.00 | 1527331.00 | 277754.00 | 1426965.00 | 224946.00 |
| Nov | 18 | 2000 | 197693.00 | 23761.00 | 1588554.00 | 285913.00 | 1373185.00 | 229281.00 |
| Nov | 25 | 2000 | 186057.00 | 23222.00 | 1631711.00 | 306069.00 | 1419337.00 | 243586.00 |
| Dec | 2 | 2000 | 192754.00 | 23853.00 | 1509076.00 | 267650.00 | 1766870.00 | 298567.00 |
| Dec | 9 | 2000 | 209916.00 | 25043.00 | 1522023.00 | 270320.00 | 1446853.00 | 236810.00 |
| Dec | 16 | 2000 | 202594.00 | 24469.00 | 1497425.00 | 262959.00 | 1375598.00 | 224165.00 |
| Dec | 23 | 2000 | 269237.00 | 32401.00 | 1342975.00 | 232437.00 | 1341084.00 | 205599.00 |
| Dec | 30 | 2000 | 177248.00 | 20651.00 | 938842.00 | 161940.00 | 945100.00 | 147138.00 |
| Jan | 6 | 2001 | 169806.00 | 19670.00 | 1246244.00 | 221111.00 | 1225127.00 | 200876.00 |
| Jan | 13 | 2001 | 174157.00 | 21116.00 | 1766952.00 | 352711.00 | 1473725.00 | 252664.00 |
| Jan | 20 | 2001 | 204104.00 | 24634.00 | 1962108.00 | 384375.00 | 1625299.00 | 272570.00 |
| Jan | 27 | 2001 | 189857.00 | 23852.00 | 1623186.00 | 302886.00 | 1343821.00 | 223495.00 |
| Feb | 3 | 2001 | 185462.00 | 23355.00 | 1647366.00 | 292041.00 | 1806473.00 | 329323.00 |
| Feb | 10 | 2001 | 168293.00 | 21312.00 | 1900316.00 | 363459.00 | 1504971.00 | 245543.00 |
| Feb | 17 | 2001 | 174372.00 | 21706.00 | 1576317.00 | 296956.00 | 1458043.00 | 262579.00 |
| Feb | 24 | 2001 | 177170.00 | 22179.00 | 1721428.00 | 327286.00 | 1377399.00 | 224093.00 |
| Mar | 3 | 2001 | 187762.00 | 23856.00 | 1549214.00 | 284463.00 | 1739081.00 | 282044.00 |
| Mar | 10 | 2001 | 172723.00 | 21934.00 | 1647889.00 | 293753.00 | 1367024.00 | 226820.00 |
| Mar | 17 | 2001 | 195144.00 | 23950.00 | 1588077.00 | 297664.00 | 1369461.00 | 224982.00 |
| Mar | 24 | 2001 | 185625.00 | 23490.00 | 1674526.00 | 314441.00 | 1516076.00 | 235313.00 |
| Mar | 31 | 2001 | 201946.00 | 24716.00 | 1744855.00 | 321436.00 | 1833254.00 | 330983.00 |
| April | 7 | 2001 | 176803.00 | 22040.00 | 1757875.00 | 336188.00 | 1411239.00 | 227698.00 |
| April | 14 | 2001 | 173560.00 | 21710.00 | 1526402.00 | 277440.00 | 1254443.00 | 189363.00 |
| April | 21 | 2001 | 156139.00 | 19523.00 | 1523463.00 | 290725.00 | 1410774.00 | 223015.00 |
| April | 28 | 2001 | 177523.00 | 22395.00 | 1967217.00 | 369651.00 | 1441487.00 | 236219.00 |
| May | 5 | 2001 | 202151.00 | 25192.00 | 2034286.00 | 386771.00 | 1394210.00 | 228741.00 |
| May | 12 | 2001 | 224357.00 | 27234.00 | 1760169.00 | 346584.00 | 1369190.00 | 223332.00 |
| May | 19 | 2001 | 210880.00 | 25824.00 | 1799444.00 | 335507.00 | 1648063.00 | 298509.00 |
| May | 26 | 2001 | 181329.00 | 22115.00 | 1722250.00 | 322681.00 | 1663243.00 | 259132.00 |
| June | 2 | 2001 | 230974.00 | 28671.00 | 2020752.00 | 355048.00 | 1776625.00 | 293308.00 |
| June | 9 | 2001 | 215550.00 | 25688.00 | 2014412.00 | 372932.00 | 1392945.00 | 239016.00 |
| June | 16 | 2001 | 199424.00 | 24206.00 | 1843340.00 | 350197.00 | 1578673.00 | 250860.00 |
| June | 23 | 2001 | 198664.00 | 24200.00 | 1675924.00 | 298594.00 | 1419258.00 | 270067.00 |
| June | 30 | 2001 | 197565.00 | 23769.00 | 1988578.00 | 387166.00 | 1300093.00 | 214839.00 |
| July | 7 | 2001 | 178801.00 | 21354.00 | 1798148.00 | 337150.00 | 1537837.00 | 228172.00 |
| July | 14 | 2001 | 191432.00 | 23299.00 | 1981358.00 | 352687.00 | 1376187.00 | 227587.00 |
| July | 21 | 2001 | 191703.00 | 23217.00 | 1704565.00 | 311299.00 | 1393427.00 | 232736.00 |
| July | 28 | 2001 | 189245.00 | 23227.00 | 1975223.00 | 379994.00 | 1287475.00 | 220353.00 |
| Aug | 4 | 2001 | 200960.00 | 24606.00 | 1741972.00 | 325748.00 | 1190521.00 | 206990.00 |
| Aug | 11 | 2001 | 184568.00 | 22635.00 | 1714007.00 | 307718.00 | 1490683.00 | 270488.00 |
| Aug | 18 | 2001 | 184254.00 | 22247.00 | 1638229.00 | 298748.00 | 1348525.00 | 219394.00 |
| Aug | 25 | 2001 | 196746.00 | 23894.00 | 1700118.00 | 305069.00 | 1170009.00 | 197069.00 |
| Sep | 1 | 2001 | 213742.00 | 25448.00 | 1955985.00 | 349721.00 | 1364371.00 | 221690.00 |
| Sep | 8 | 2001 | 190253.00 | 22542.00 | 1835043.00 | 338683.00 | 1193752.00 | 205379.00 |
| Sep | 15 | 2001 | 201608.00 | 23317.00 | 1866550.00 | 356526.00 | 1311044.00 | 241131.00 |
| Sep | 22 | 2001 | 191965.00 | 22803.00 | 2095745.00 | 390247.00 | 1381506.00 | 246012.00 |
| Sep | 29 | 2001 | 189192.00 | 22364.00 | 1897522.00 | 339363.00 | 1365288.00 | 241265.00 |
| Oct | 6 | 2001 | 185960.00 | 21917.00 | 1614625.00 | 279264.00 | 1299487.00 | 230310.00 |
| Oct | 13 | 2001 | 168545.00 | 20413.00 | 1486265.00 | 254242.00 | 1063855.00 | 184994.00 |
| Oct | 20 | 2001 | 204803.00 | 25340.00 | 1644538.00 | 281821.00 | 1182249.00 | 214296.00 |
| Oct | 27 | 2001 | 217929.00 | 25479.00 | 1758644.00 | 298338.00 | 1248027.00 | 218192.00 |
| Nov | 3 | 2001 | 207307.00 | 24620.00 | 1839513.00 | 332640.00 | 1219017.00 | 216376.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | drumt11 | drumt12 | thigh11 | thigh12 | ast11 | ast12 |
| Nov | 10 | 2001 | 204158.00 | 24946.00 | 1750407.00 | 307215.00 | 1162222.00 | 203749.00 |
| Nov | 17 | 2001 | 183515.00 | 21442.00 | 1593426.00 | 274431.00 | 1017525.00 | 181172.00 |
| Nov | 24 | 2001 | 215611.00 | 24321.00 | 1701677.00 | 315694.00 | 1278784.00 | 230030.00 |
| Dec | 1 | 2001 | 219679.00 | 25327.00 | 1715144.00 | 294453.00 | 1168756.00 | 199509.00 |
| Dec | 8 | 2001 | 191600.00 | 22167.00 | 1722191.00 | 303003.00 | 1144305.00 | 200232.00 |
| Dec | 15 | 2001 | 221697.00 | 25924.00 | 1569796.00 | 275029.00 | 1018825.00 | 172472.00 |
| Dec | 22 | 2001 | 261552.00 | 29296.00 | 1459204.00 | 239326.00 | 1053256.00 | 173944.00 |
| Dec | 29 | 2001 | 185288.00 | 20948.00 | 947126.00 | 155409.00 | 721283.00 | 118065.00 |
| Jan | 5 | 2002 | 233024.00 | 28054.00 | 1413646.00 | 245037.00 | 1046146.00 | 160566.00 |
| Jan | 12 | 2002 | 184882.00 | 21528.00 | 1982373.00 | 422278.00 | 1475940.00 | 240575.00 |
| Jan | 19 | 2002 | 206217.00 | 23825.00 | 1873216.00 | 324012.00 | 1269608.00 | 228244.00 |
| Jan | 26 | 2002 | 201402.00 | 25017.00 | 1641598.00 | 288285.00 | 1286685.00 | 224757.00 |
| Feb | 2 | 2002 | 224220.00 | 25581.00 | 1840609.00 | 338304.00 | 1277718.00 | 236583.00 |
| Feb | 9 | 2002 | 193368.00 | 23847.00 | 1833519.00 | 327164.00 | 1082112.00 | 194504.00 |
| Feb | 16 | 2002 | 176480.00 | 20595.00 | 1707330.00 | 327444.00 | 1034288.00 | 173029.00 |
| Feb | 23 | 2002 | 190285.00 | 22185.00 | 1661102.00 | 292061.00 | 1314071.00 | 234352.00 |
| Mar | 2 | 2002 | 200076.00 | 24904.00 | 2686174.00 | 459003.00 | 1071675.00 | 196306.00 |
| Mar | 9 | 2002 | 205399.00 | 23363.00 | 1787525.00 | 311166.00 | 1061081.00 | 182495.00 |
| Mar | 16 | 2002 | 210543.00 | 23964.00 | 1921268.00 | 345678.00 | 1326353.00 | 263719.00 |
| Mar | 23 | 2002 | 187765.00 | 21847.00 | 1684253.00 | 301457.00 | 1145225.00 | 211579.00 |
| Mar | 30 | 2002 | 191179.00 | 22036.00 | 1581059.00 | 270929.00 | 1022732.00 | 203513.00 |
| April | 6 | 2002 | 169864.00 | 19790.00 | 1558371.00 | 277612.00 | 990531.00 | 185929.00 |
| April | 13 | 2002 | 173814.00 | 20556.00 | 1873095.00 | 343757.00 | 1075742.00 | 222764.00 |
| April | 20 | 2002 | 182304.00 | 21214.00 | 1711785.00 | 314527.00 | 1102676.00 | 233463.00 |
| April | 27 | 2002 | 183049.00 | 21314.00 | 1678568.00 | 294213.00 | 1242001.00 | 247604.00 |
| May | 4 | 2002 | 206730.00 | 23826.00 | 1858057.00 | 326887.00 | 1137100.00 | 225449.00 |
| May | 11 | 2002 | 186037.00 | 21720.00 | 1894615.00 | 329082.00 | 1450818.00 | 289009.00 |
| May | 18 | 2002 | 184020.00 | 21355.00 | 1954812.00 | 331614.00 | 1250637.00 | 257185.00 |
| May | 25 | 2002 | 170519.00 | 19844.00 | 1674898.00 | 298888.00 | 1438072.00 | 240557.00 |
| June | 1 | 2002 | 187780.00 | 21558.00 | 1907810.00 | 349612.00 | 1243326.00 | 241252.00 |
| June | 8 | 2002 | 182327.00 | 21540.00 | 1783780.00 | 322419.00 | 1161029.00 | 235847.00 |
| June | 15 | 2002 | 180095.00 | 21073.00 | 1828908.00 | 325154.00 | 1289904.00 | 246017.00 |
| June | 22 | 2002 | 173326.00 | 20541.00 | 1641934.00 | 280531.00 | 1288006.00 | 251214.00 |
| June | 29 | 2002 | 173957.00 | 20803.00 | 1848042.00 | 324854.00 | 1261939.00 | 247023.00 |
| July | 6 | 2002 | 163019.00 | 19183.00 | 1701204.00 | 305175.00 | 1080142.00 | 210335.00 |
| July | 13 | 2002 | 159855.00 | 20190.00 | 1835820.00 | 351037.00 | 1014096.00 | 204150.00 |
| July | 20 | 2002 | 165367.00 | 19909.00 | 1739834.00 | 313235.00 | 1257322.00 | 274008.00 |
| July | 27 | 2002 | 160235.00 | 19164.00 | 1867172.00 | 327046.00 | 1029748.00 | 209859.00 |
| Aug | 3 | 2002 | 175519.00 | 21201.00 | 1962779.00 | 359702.00 | 1208198.00 | 220742.00 |
| Aug | 10 | 2002 | 168577.00 | 20094.00 | 2605560.00 | 455289.00 | 1317515.00 | 354975.00 |
| Aug | 17 | 2002 | 165204.00 | 19679.00 | 1755934.00 | 340793.00 | 1044403.00 | 227032.00 |
| Aug | 24 | 2002 | 158169.00 | 18744.00 | 1792570.00 | 312492.00 | 1254892.00 | 227172.00 |
| Aug | 31 | 2002 | 180931.00 | 21031.00 | 2094218.00 | 400552.00 | 1175631.00 | 237935.00 |
| Sep | 7 | 2002 | 165396.00 | 18371.00 | 2715502.00 | 471122.00 | 1247179.00 | 247914.00 |
| Sep | 14 | 2002 | 137475.00 | 15733.00 | 1771112.00 | 329728.00 | 1111643.00 | 219216.00 |
| Sep | 21 | 2002 | 133537.00 | 15367.00 | 1889575.00 | 345297.00 | 1051005.00 | 213534.00 |
| Sep | 28 | 2002 | 135317.00 | 15565.00 | 1893971.00 | 322292.00 | 1275262.00 | 237360.00 |
| Oct | 5 | 2002 | 150930.00 | 17282.00 | 1917691.00 | 339920.00 | 1142364.00 | 241186.00 |
| Oct | 12 | 2002 | 135761.00 | 15479.00 | 1545509.00 | 258587.00 | 1140982.00 | 229383.00 |
| Oct | 19 | 2002 | 124745.00 | 14576.00 | 1507476.00 | 247895.00 | 1272746.00 | 230002.00 |
| Oct | 26 | 2002 | 129510.00 | 14821.00 | 1995949.00 | 342973.00 | 1284044.00 | 266520.00 |

| Fresh | | | val ($) | quant (kg) | val ($) | quant (kg) | val ($) | quant (kg) |
|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | drumt11 | drumt12 | thigh11 | thigh12 | ast11 | ast12 |
| Nov | 2 | 2002 | 140030.00 | 16241.00 | 2238442.00 | 443140.00 | 1376417.00 | 278284.00 |
| Nov | 9 | 2002 | 146192.00 | 17173.00 | 2060564.00 | 352478.00 | 1114531.00 | 210900.00 |
| Nov | 16 | 2002 | 144011.00 | 16524.00 | 1706947.00 | 278266.00 | 1137312.00 | 206546.00 |
| Nov | 23 | 2002 | 151940.00 | 17025.00 | 2563596.00 | 434898.00 | 1059855.00 | 207462.00 |
| Nov | 30 | 2002 | 149852.00 | 16686.00 | 1854217.00 | 306321.00 | 1076940.00 | 224662.00 |
| Dec | 7 | 2002 | 165011.00 | 18943.00 | 1757888.00 | 286902.00 | 1126535.00 | 229715.00 |
| Dec | 14 | 2002 | 185995.00 | 21462.00 | 1772002.00 | 321438.00 | 1085617.00 | 230741.00 |
| Dec | 21 | 2002 | 230917.00 | 27949.00 | 1561650.00 | 251202.00 | 1028396.00 | 199219.00 |
| Dec | 28 | 2002 | 188936.00 | 22486.00 | 1048856.00 | 163663.00 | 795748.00 | 180055.00 |
| Jan | 4 | 2003 | 216920.00 | 24256.00 | 1436410.00 | 232939.00 | 886921.00 | 174127.00 |
| Jan | 11 | 2003 | 169622.00 | 19583.00 | 1859237.00 | 320422.00 | 1216870.00 | 233581.00 |
| Jan | 18 | 2003 | 160959.00 | 19219.00 | 1961167.00 | 353355.00 | 1237837.00 | 233971.00 |
| Jan | 25 | 2003 | 177693.00 | 20486.00 | 1801258.00 | 296063.00 | 1183075.00 | 227959.00 |
| Feb | 1 | 2003 | 176461.00 | 21307.00 | 1983119.00 | 356516.00 | 1697015.00 | 353045.00 |
| Feb | 8 | 2003 | 159549.00 | 18409.00 | 2122750.00 | 380119.00 | 1153009.00 | 229638.00 |
| Feb | 15 | 2003 | 143115.00 | 16611.00 | 1791076.00 | 303205.00 | 1162086.00 | 219214.00 |
| Feb | 22 | 2003 | 187996.00 | 20597.00 | 2028023.00 | 336129.00 | 1176534.00 | 229817.00 |
| Mar | 1 | 2003 | 160840.00 | 18624.00 | 1991680.00 | 376328.00 | 1090113.00 | 206254.00 |
| Mar | 8 | 2003 | 187582.00 | 23058.00 | 2766449.00 | 488013.00 | 1084685.00 | 209149.00 |
| Mar | 15 | 2003 | 169000.00 | 18800.00 | 2063148.00 | 387251.00 | 1178392.00 | 211467.00 |
| Mar | 22 | 2003 | 148134.00 | 17135.00 | 2021306.00 | 372678.00 | 1138392.00 | 216066.00 |
| Mar | 29 | 2003 | 149617.00 | 17224.00 | 2049525.00 | 329014.00 | 1395901.00 | 278296.00 |
| April | 5 | 2003 | 181788.00 | 21811.00 | 2210784.00 | 351582.00 | 1300439.00 | 252125.00 |
| April | 12 | 2003 | 158285.00 | 17971.00 | 1793709.00 | 280366.00 | 1181031.00 | 230538.00 |
| April | 19 | 2003 | 169266.00 | 19377.00 | 1762809.00 | 274629.00 | 1122381.00 | 201168.00 |
| April | 26 | 2003 | 133496.00 | 14985.00 | 1840642.00 | 303829.00 | 1014053.00 | 192037.00 |
| May | 3 | 2003 | 175458.00 | 20483.00 | 2144409.00 | 352907.00 | 1277167.00 | 234467.00 |
| May | 10 | 2003 | 180790.00 | 20850.00 | 2801289.00 | 424579.00 | 1412127.00 | 229227.00 |
| May | 17 | 2003 | 165748.00 | 18924.00 | 2030062.00 | 346710.00 | 1169228.00 | 211446.00 |
| May | 24 | 2003 | 198735.00 | 22806.00 | 2275951.00 | 407414.00 | 1216484.00 | 203558.00 |
| May | 31 | 2003 | 167590.00 | 19459.00 | 2148257.00 | 363734.00 | 1504676.00 | 264324.00 |
| June | 7 | 2003 | 162819.00 | 18715.00 | 2127103.00 | 339080.00 | 1356196.00 | 245041.00 |
| June | 14 | 2003 | 162885.00 | 18473.00 | 2026461.00 | 325460.00 | 1205177.00 | 214533.00 |
| June | 21 | 2003 | 154149.00 | 17627.00 | 2660539.00 | 410349.00 | 1167717.00 | 190336.00 |
| June | 28 | 2003 | 157228.00 | 17979.00 | 2045045.00 | 333222.00 | 1294778.00 | 201556.00 |
| July | 5 | 2003 | 164126.00 | 18976.00 | 2292617.00 | 385540.00 | 1112674.00 | 183176.00 |
| July | 12 | 2003 | 145441.00 | 16647.00 | 1886486.00 | 313897.00 | 1149319.00 | 221432.00 |
| July | 19 | 2003 | 163877.00 | 19007.00 | 2058071.00 | 333879.00 | 1052476.00 | 185344.00 |
| July | 26 | 2003 | 148297.00 | 17050.00 | 2698165.00 | 423611.00 | 1270745.00 | 218642.00 |
| Aug | 2 | 2003 | 157668.00 | 18083.00 | 2119999.00 | 353425.00 | 1083166.00 | 178923.00 |
| Aug | 9 | 2003 | 154296.00 | 17672.00 | 1959234.00 | 335780.00 | 1186890.00 | 192653.00 |
| Aug | 16 | 2003 | 147583.00 | 16771.00 | 1779370.00 | 286507.00 | 967153.00 | 177037.00 |
| Aug | 23 | 2003 | 144484.00 | 16574.00 | 1875566.00 | 305323.00 | 1035597.00 | 179954.00 |
| Aug | 30 | 2003 | 162857.00 | 18401.00 | 2093153.00 | 343039.00 | 1157905.00 | 208629.00 |
| Sep | 6 | 2003 | 156184.00 | 17814.00 | 2696064.00 | 409893.00 | 1076363.00 | 182209.00 |
| Sep | 13 | 2003 | 152707.00 | 17540.00 | 1947453.00 | 314826.00 | 1101789.00 | 205663.00 |
| Sep | 20 | 2003 | 155570.00 | 17640.00 | 2358049.00 | 378365.00 | 1118517.00 | 208794.00 |
| Sep | 27 | 2003 | 147589.00 | 17037.00 | 1965042.00 | 319482.00 | 1079566.00 | 191405.00 |
| Oct | 4 | 2003 | 155837.00 | 17809.00 | 2774704.00 | 415830.00 | 1099947.00 | 194774.00 |
| Oct | 11 | 2003 | 160866.00 | 18973.00 | 1874362.00 | 300911.00 | 1069538.00 | 197625.00 |
| Oct | 18 | 2003 | 138105.00 | 15823.00 | 1587008.00 | 258521.00 | 901003.00 | 182856.00 |
| Oct | 25 | 2003 | 154312.00 | 18065.00 | 2214373.00 | 363233.00 | 1237664.00 | 213201.00 |
| Nov | 1 | 2003 | 196823.00 | 23912.00 | 2166702.00 | 366570.00 | 1204804.00 | 217696.00 |